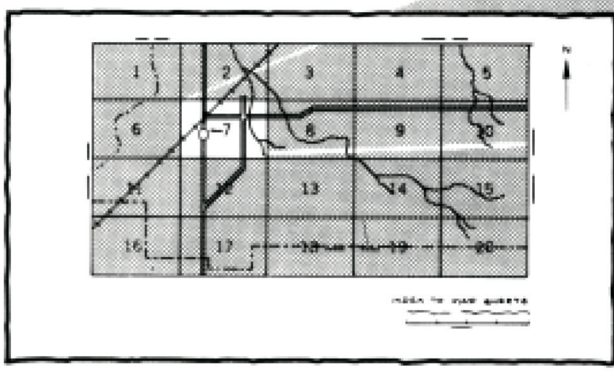
SOIL SURVEY OF

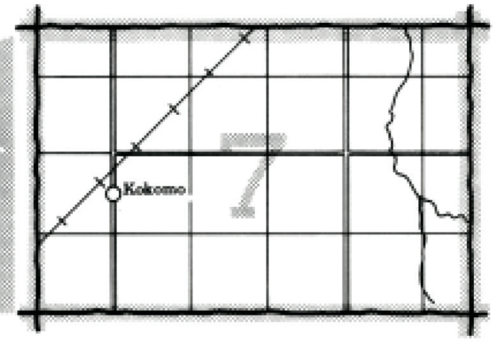
Dickinson County, Kansas

United States Department of Agriculture,
Soil Conservation Service,
in cooperation with
Kansas Agricultural Experiment Station

HOW TO USE

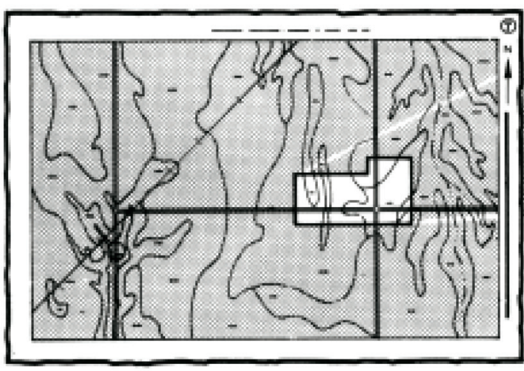
1. Locate your area of interest on the "Index to Map Sheets"

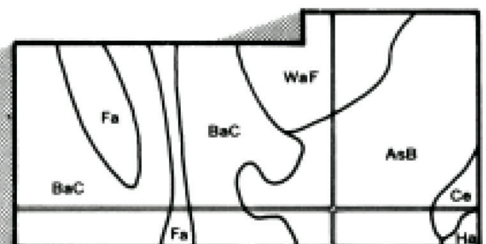




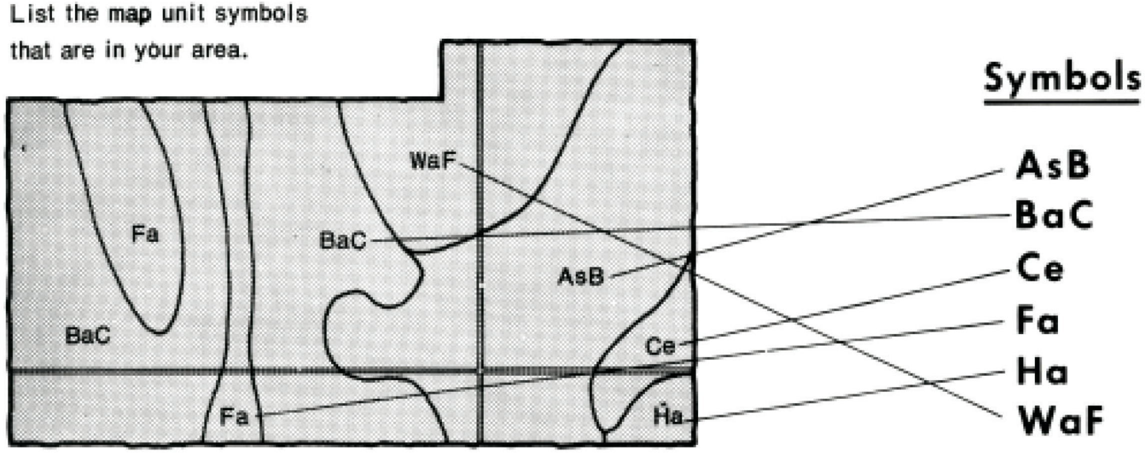
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



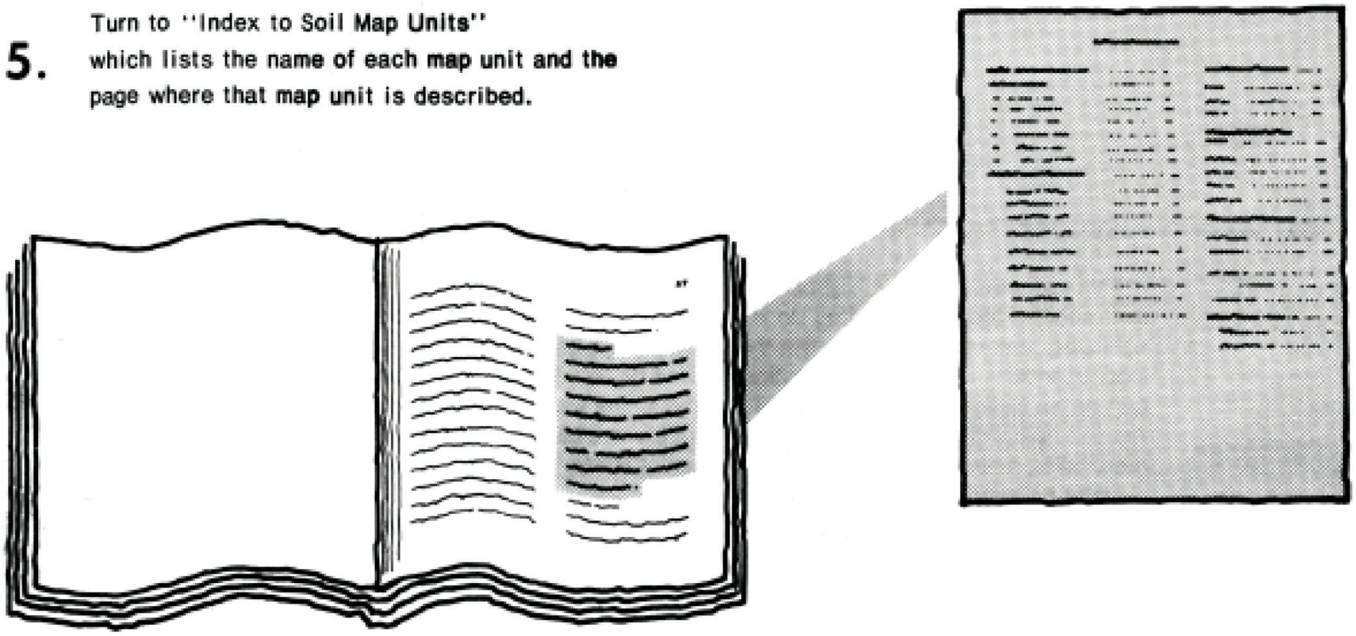


4. List the map unit symbols that are in your area.

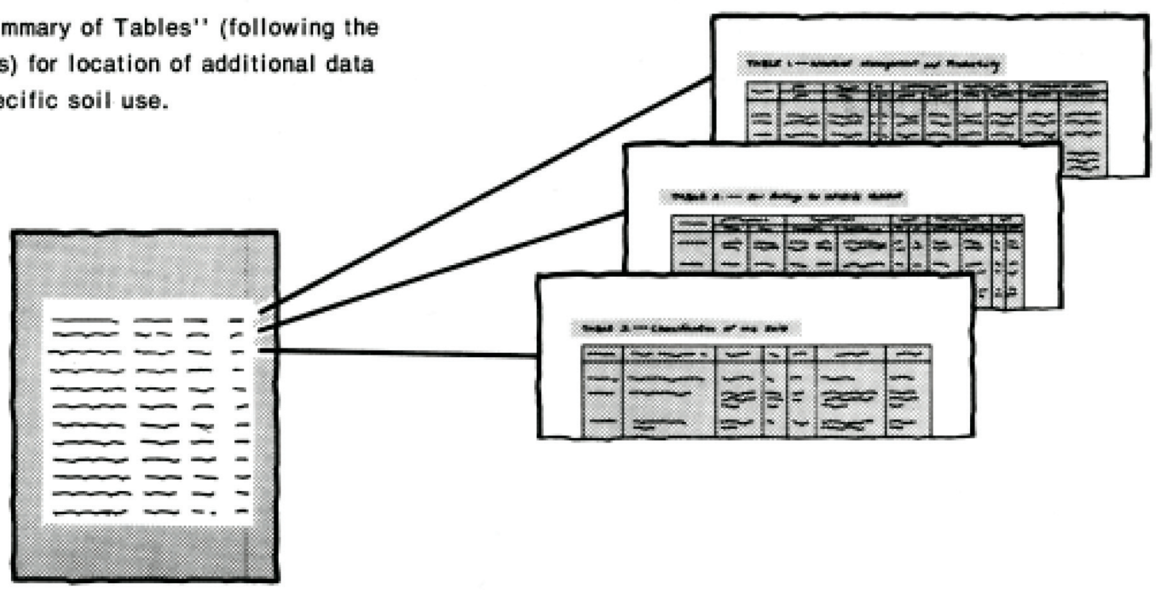


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1969 to 1976. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1976. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Dickinson County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: Terrace constructed to control erosion on Crete silty clay loam, 1 to 3 percent slopes.

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Issued January 1980

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Foreword

The Soil Survey of Dickinson County, Kansas contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

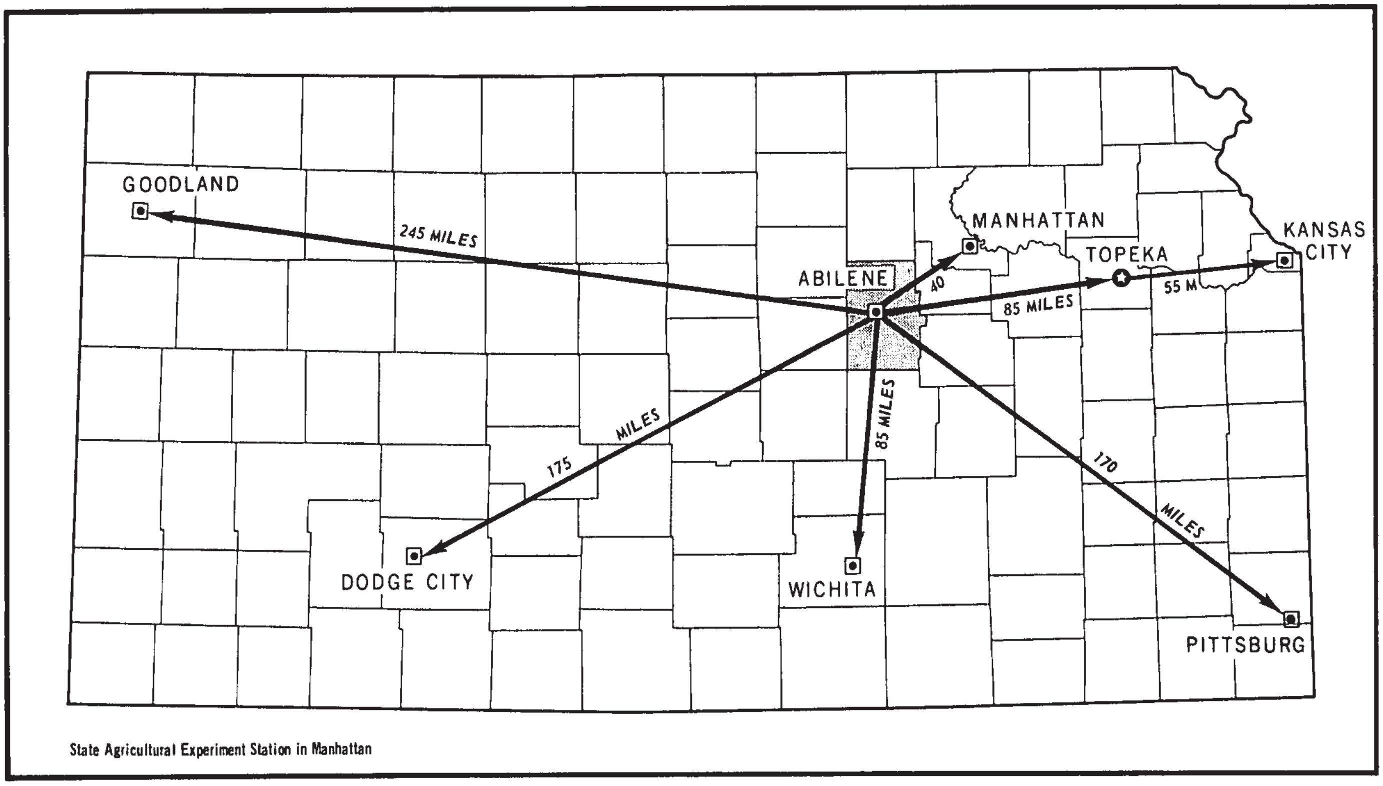
This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

Robert K. Griffin
State Conservationist
Soil Conservation Service



Location of Dickinson County in Kansas.

SOIL SURVEY OF DICKINSON COUNTY, KANSAS

By Donald R. Jantz and Orville W. Saffry, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with Kansas Agricultural Experiment Station

DICKINSON COUNTY is near the center of Kansas (see map on facing page). The county has a total area of 855 square miles or 547,200 acres. The population was 22,550 in 1977. In that year Abilene, the county seat, had a population of 7,312.

Dickinson County was organized in 1857. It is in the Central Loess Plains land resource area. The soils are generally deep and nearly level to moderately sloping, with a clayey or silty subsoil. Elevation ranges from 1,100 to 1,590 feet above sea level.

Most of Dickinson County is drained by the Smoky Hill River and its tributaries.

Dickinson County has a continental climate. Summers are hot and winters are cold. Mean annual temperature is 43 to 67 degrees F. Annual precipitation ranges from 25 to 40 inches.

The main enterprises in the county are farming and ranching. Wheat and grain sorghum are the main crops.

General nature of the county

This section provides information that may be useful to persons not familiar with Dickinson County. It discusses climate and natural resources.

Climate

By L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Dickinson County is a typical continental type, as would be expected from its location in the interior of a large land mass in the middle latitudes. Such climate is characterized by large daily and annual variations in temperature. Winter is cold because of the frequent outbreaks of air from the Polar regions, however, it only lasts from December through February. Warm temperatures of summer last for about 6 months every year, with the transition seasons of spring and fall being relatively short. The warm temperatures provide a long growing season for crops in the county.

Dickinson County is generally along the western edge of the flow of moisture-laden air from the Gulf of Mexico. Shifts in this current produce a rather large range in the amount of precipitation received. Precipitation is heaviest from May through September, with a large part of it coming from late-evening or night-time thunderstorms. Precipitation in dry years is marginal for agricultural production, and even in wet years there are often prolonged periods without rain that produce stress in growing crops.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Herington for the period 1941 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 32.0 degrees F, and the average daily minimum temperature is 21.4 degrees. The lowest temperature on record, which occurred at Abilene on February 12, 1899, is -29 degrees. In summer the average temperature is 76.9 degrees, and the average daily maximum temperature is 88.6 degrees. The highest recorded temperature, which occurred at Herington on August 13, 1936, is 113 degrees.

Of the total annual precipitation, 23.97 inches, or 71 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 16.10 inches. The heaviest 1-day rainfall during the period of record was 6.44 inches at Herington on October 7, 1967.

Average seasonal snowfall is 22.8 inches. On the average, 20 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The percentage of possible sunshine is 70 in summer and 59 in winter. The prevailing wind is from the south.

Average windspeed is highest, 13 miles per hour, in March and April.

Tornadoes and severe thunderstorms occur occasionally in Dickinson County. These storms are usually local in extent and of short duration, so risk is small. Hail occurs during the warmer part of the year, but again, it is infrequent and of local extent. Crop damage by hail occurs less in this part of the state than further west.

Natural resources

The most valuable natural resource in Dickinson County is its soils. Most of the soils are fertile and well suited to agricultural uses. Irrigation water of suitable quality and quantity is available in some areas near the Smoky Hill River.

Limestone that can be quarried is in the eastern parts of the county. It can be used as a source of crushed rock, as agricultural lime, and in the manufacture of other limestone products. Sand is available from pits along the Smoky Hill River and from areas of sandy soils between Abilene and Solomon.

Some oil is produced in the county.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

1. Crete-Irwin-Geary

Deep, nearly level to moderately sloping soils that have a silty surface layer; on uplands

The soils in this map unit are on broad ridgetops and side slopes along intermittent drainageways. This map unit makes up about 27 percent of the county. It is about 53 percent Crete soils, 22 percent Irwin soils, 15 percent Geary soils, and 10 percent soils of minor extent (fig. 1).

The deep, moderately well drained and somewhat poorly drained Crete soils are on broad divides and ridgetops. Typically, the surface layer is dark gray silty clay loam about 8 inches thick. The subsoil is about 32 inches thick. The upper part is dark grayish brown, friable silty clay loam; the middle part is brown and grayish brown, firm silty clay; and the lower part is brown, firm silty clay loam. The substratum to a depth of about 60 inches is brown and light brownish gray silty clay loam.

The deep, well drained and moderately well drained Irwin soils are on narrow ridgetops and side slopes. Typically, the surface layer is dark gray silty clay loam about 9 inches thick. The subsoil is firm silty clay about 30 inches thick. The upper part is dark grayish brown, the middle part is grayish brown, and the lower part is brown. The substratum, to a depth of about 60 inches is multicolored silty clay.

The deep, well drained Geary soils are on side slopes along the river and creeks. Typically, the surface soil is grayish brown silt loam about 13 inches thick. The subsoil is about 39 inches thick. The upper part is brown, friable silty clay loam and the lower part is reddish brown, firm silty clay loam. The substratum, to a depth of about 60 inches is light reddish brown silty clay loam with some carbonate concretions.

The soils of minor extent are moderately deep Clime soils on side slopes and Hobbs, Muir, and Sutphen soils on bottom lands.

Most of the soils in this map unit are used for cultivated crops, but some small areas are used for hay and pasture. The most common crops are wheat and grain sorghum. Erosion is a hazard in the gently sloping and moderately sloping areas. The soils are droughty during dry periods. Controlling erosion and maintaining soil tilth and fertility are the main management concerns.

The soils in this map unit have good potential for cropland, pasture, and range and have fair potential for openland and rangeland wildlife habitat. They have fair to poor potential for building site development and sanitary facilities.

2. Irwin-Clime

Deep and moderately deep, gently sloping to strongly sloping soils that have a silty surface layer; on uplands

The soils in this map unit are on broad ridgetops that are dissected by intermittent drainageways.

This map unit makes up about 37 percent of the county. It is about 78 percent Irwin soils, 14 percent Clime soils, and 8 percent soils of minor extent (fig. 2).

The deep, well drained and moderately well drained Irwin soils are on ridgetops and side slopes. Typically, the surface layer is dark gray silty clay loam about 8 inches thick. The subsoil is firm silty clay about 28 inches thick. The upper part is dark grayish brown, the middle part is grayish brown, and the lower part is brown. The substratum to a depth of about 60 inches is multicolored silty clay.

The moderately deep, well drained Clime soils are on side slopes adjacent to drainageways. Typically, the surface layer is dark grayish brown silty clay loam about 10 inches thick. The subsoil is grayish brown, friable silty clay loam about 9 inches thick. The substratum is light brownish gray silty clay about 8 inches thick. Calcareous, clayey shale is at a depth of about 27 inches.

The soils of minor extent are somewhat poorly drained Crete soils on broad ridgetops, well drained Geary soils on side slopes, and ocassionally flooded Hobbs soils on small bottom land areas.

The soils in this map unit are used mainly for cultivated crops, but some small areas are used for hay and pasture. The most common crops grown are wheat and grain sorghum. Erosion is a hazard. Controlling erosion and maintaining soil fertility are the main management concerns on these soils.

These soils have good potential for cropland, pasture, and range and fair potential for openland and rangeland wildlife habitat. They have fair to poor potential for building site development and sanitary facilities.

3. Irwin-Clime-Sogn

Deep to shallow, gently sloping to moderately steep soils that have a silty surface layer; on uplands

The soils in this map unit are on ridgetops and side slopes. Drainageways are deeply entrenched, and limestone outcrops are common on the landscape.

This map unit makes up about 17 percent of the county. It is about 55 percent Irwin soils, 20 percent Clime soils, 5 percent Sogn soils, and 20 percent soils of minor extent.

The deep, well drained and moderately well drained Irwin soils are on gently sloping ridgetops and moderately sloping side slopes. Typically, the surface layer is dark gray silty clay loam about 9 inches thick. The subsoil is firm silty clay about 30 inches thick. The upper part is dark grayish brown, the middle part is grayish brown, and the lower part is brown. The substratum to a depth of about 60 inches is multicolored silty clay.

The moderately deep, well drained Clime soils are on moderately steep side slopes. Typically, the surface layer is dark grayish brown silty clay loam about 10 inches thick. The subsoil is grayish brown, friable silty clay loam

about 9 inches thick. The substratum is light brownish gray silty clay about 8 inches thick. Calcareous, clayey shale is at a depth of about 27 inches.

The shallow, somewhat excessively drained Sogn soils are moderately sloping. Typically, the surface soil is dark gray silt loam about 14 inches thick. Hard limestone bedrock is at a depth of about 14 inches.

The soils of minor extent are the Crete soils on nearly level ridgetops and Hobbs and Muir soils on bottom lands along small creeks.

Most of the soils in this map unit are used for native range. Some of the Irwin soils and soils of minor extent are cultivated. Rangeland management is mainly concerned with the maintenance of a good cover of mid and tall native grasses. Many areas require brush management.

The soils in this map unit have good potential for pasture and rangeland and for openland wildlife habitat. They have fair potential for cropland and poor potential for building site development and sanitary facilities.

4. Muir-Hobbs-Sutphen

Deep, nearly level soils that have a silty or clayey surface layer; on bottom lands

The soils in this map unit are on bottom lands of the Smoky Hill River and larger creeks. The bottom lands are more than one-half mile wide.

This map unit makes up about 13 percent of the county. It is about 27 percent Muir soils, 25 percent Hobbs soils, 18 percent Sutphen soils, and 30 percent soils of minor extent.

The deep, well drained Muir soils are on terraces and high bottoms that rarely flood. Typically, the surface layer is dark gray silt loam about 8 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsoil is about 33 inches thick. It is grayish brown, friable silt loam in the upper part and friable silty clay loam in the lower part. The substratum to a depth of about 60 inches is grayish brown silty clay loam.

The deep, well drained Hobbs soils are on flood plains that occasionally flood. Typically, the surface layer is dark gray silt loam about 8 inches thick. The substratum to a depth of about 60 inches is dark grayish brown and dark gray silt loam.

The deep, moderately well drained and somewhat poorly drained Sutphen soils are on the terrace. Typically, the surface layer is dark gray silty clay loam or silty clay about 12 inches thick. The subsurface layer is very dark gray, very firm silty clay about 14 inches thick. The next layer is dark gray, very firm silty clay about 8 inches thick. The substratum to a depth of about 60 inches is grayish brown silty clay and brown silty clay loam containing lime concretions.

The soils of minor extent are clayey Detroit soils on the terrace and silty McCook soils and clayey Solomon soils on the flood plain.

Most of the soils in this map unit are used for cultivated crops. The most common crops are wheat, grain sorghum, forage sorghum, alfalfa, and soybeans. Maintaining fertility and good tilth are management concerns.

These soils have good potential for cropland, pasture, range, and openland and rangeland wildlife habitat. They have poor potential for building site development and sanitary facilities.

5. Valentine-Ortello-Wells

Deep, undulating and rolling soils that have a sandy or loamy surface layer; on uplands

This map unit consists of the sandhill areas of the county.

This map unit makes up about 3 percent of the county. It is about 40 percent Valentine soils, 30 percent Ortello soils, 20 percent Wells soils, and 10 percent soils of minor extent.

The deep, excessively drained Valentine soils are on side slopes. Typically, the surface layer is grayish brown loamy fine sand about 7 inches thick. The next layer is brown, very friable loamy fine sand about 8 inches thick. The substratum to a depth of about 60 inches is light yellowish brown, loamy fine sand.

The deep, well drained Ortello soils are on lower side slopes. Typically, the surface layer is grayish brown fine sandy loam about 8 inches thick. The subsurface layer is grayish brown, very friable fine sandy loam about 8 inches thick. The subsoil is brown, very friable fine sandy loam about 19 inches thick. The substratum to a depth of about 60 inches is brown fine sandy loam and loamy fine sand.

The deep, well drained Wells soils are on upper side slopes. Typically, the surface layer is dark gray fine sandy loam about 8 inches thick. The subsurface layer is brown, friable loam about 4 inches thick. The subsoil is about 32 inches thick and is brown, friable loam in the upper part. The middle part is strong brown, friable sandy clay loam, and the lower part is light brown, friable sandy clay loam. The substratum to a depth of about 60 inches is strong brown sandy loam.

The soils of minor extent are somewhat poorly drained Carwile and Elsmere soils. They are in depressions.

Most of the soils in this map unit are used for range. The main management concern is maintaining the grass cover in good condition.

These soils have fair potential for cropland and good potential for range and openland wildlife habitat. Some soils are suited to watermelons and other specialty crops. The soils have fair to good potential for building site development and sanitary facilities.

6. Wells-Lancaster-Hedville

Deep to shallow, moderately sloping and strongly sloping soils that have a loamy surface layer; on uplands

The soils in this map unit consist of the Dakota Sandstone hills. They are on ridgetops and side slopes that are dissected by intermittent drains and small creeks. Sandstone outcrops are common on steeper areas.

This map unit makes up 3 percent of the county. It is about 30 percent Wells soils, 25 percent Lancaster soils, 10 percent Hedville soils, and 35 percent soils of minor extent (fig. 3).

The deep, well drained Wells soils are on lower side slopes. Typically, the surface layer is dark gray loam about 8 inches thick. The subsurface layer is brown, friable loam about 4 inches thick. The subsoil is about 32 inches thick and is brown, friable loam in the upper part; strong brown, friable sandy clay loam in the middle part; and light brown, friable sandy clay loam in the lower part. The substratum to a depth of about 60 inches is strong brown sandy loam.

The moderately deep, well drained Lancaster soils are on lower side slopes. Typically, the surface layer is dark grayish brown and brown loam about 11 inches thick. The subsoil is about 25 inches thick. The upper part is reddish brown, firm clay loam. The lower part is reddish yellow, friable sandy clay loam. Yellow, weathered, sandy shale is at a depth of about 36 inches.

The shallow, somewhat excessively drained Hedville soils are on upper side slopes. Typically, the surface soil, about 13 inches thick, is grayish brown in the upper part and dark brown in the lower part. The substratum is brown fine sandy loam about 3 inches thick. Brown and strong brown sandstone bedrock is at a depth of about 16 inches.

The soils of minor extent are Crete, Geary, and Irwin soils.

Most of the soils in this map unit are used for range. Management of the rangeland is mainly concerned with the maintenance of a good cover of mid and tall grasses. Some areas may require brush management.

These soils have good potential for range and poor potential for cropland. They have fair potential for rangeland and openland wildlife habitat. They have fair to poor potential for building site development and sanitary facilities.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have similar profiles make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Solomon series, for example, was named for the town of Solomon in Dickinson County.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Crete silty clay loam, 1 to 3 percent slopes, is one of several phases within the Crete series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Clime-Sogn complex, 5 to 20 percent slopes, is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Quarries is an example. Some of these areas are too small to

be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Ca—Carwile loam. This deep, nearly level, somewhat poorly drained soil is in concave areas in the uplands. Individual areas are irregular in shape and range from 10 to 400 acres.

Typically, the surface layer is dark gray loam about 7 inches thick. The subsurface layer is dark gray, friable clay loam about 7 inches thick. The subsoil is firm clay loam about 17 inches thick. It is light brownish gray in the upper part and light gray in the lower part. The substratum to a depth of 60 inches is light gray clay loam.

Included with this soil in mapping are small areas of Ortello and Valentine soils. These sandier soils are on low, irregular shaped mounds and make up 5 to 15 percent of the unit.

Permeability is slow in the Carwile soil. Surface runoff is slow, and low areas are occasionally ponded. This soil has high available water capacity and medium natural fertility. It has high shrink-swell potential. The surface layer is friable and easily tilled. Depth to the seasonal water table ranges from 0 to 2 feet.

About 75 percent of this soil is used for cropland. The rest is mainly used for rangeland. This soil has good potential for range, pasture, and openland and rangeland wildlife habitat. It has fair potential for cultivated crops. It has poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and grasses for hay and pasture. If this soil is used for cultivated crops, soil blowing and wetness are hazards. Stubble mulching helps to prevent soil blowing and increase water infiltration. A system of shallow ditches or furrows, where outlets are available, helps to reduce wetness.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has severe limitations for dwellings because of wetness and shrink-swell potential. Grading to provide good surface drainage helps to reduce wetness. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. This soil has severe limitations for septic tank absorption fields because of slow permeability and wetness. Increasing the size of the absorption field helps to improve the functioning of septic tank systems. Onsite investigations are needed to locate included sandier soils with more favorable permeability. This soil is suited to sewage lagoons. It has severe limitations for local roads and streets because of shrink-swell potential and low strength. Strengthening or replacing the base material helps to overcome these limitations.

This soil is in capability subclass IIw.

Cb—Clime silty clay loam, 2 to 6 percent slopes. This moderately deep, well drained, moderately sloping soil is on uplands (fig. 4). It is on narrow ridgetops and convex upper side slopes. Individual areas are irregular in shape and range from 4 to 80 acres or more.

Typically, the surface layer is dark grayish brown silty clay loam about 10 inches thick. The subsoil is grayish brown, friable silty clay loam about 9 inches thick. The substratum is light brownish gray silty clay about 8 inches thick. Calcareous, clayey shale is at a depth of about 27 inches (fig. 5).

In some places, channery shale and limestone fragments are on the surface and in the surface layer. Also, in some places part of the original surface layer is eroded. As a result of plowing, the present surface layer is a mixture of material from the upper part of the subsoil and the original surface layer.

Included with this soil in mapping are small areas of deep Irwin soils. Irwin soils are on the lower parts of the side slopes and make up 5 to 10 percent of the unit.

Permeability is moderately slow, surface runoff is rapid, and available water capacity is low in the Clime soil. This soil has moderate shrink-swell potential. It is calcareous and is moderately alkaline throughout. The rooting zone extends to clayey shale at a depth of 20 to 40 inches. Natural fertility is low.

About 50 percent of this soil is used for cropland and the rest is mainly used for rangeland. This soil has good potential for range and pasture. It has fair potential for cultivated crops and openland and rangeland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, grain sorghum, and grasses for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion. Minimum tillage, grassed waterways, terraces, and farming on the contour help to prevent excessive soil loss. Returning crop residue to the soil helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has a moderate limitation for dwellings because of shrink-swell potential. Using properly designed and reinforced foundations and installing foundation drains help to prevent structural damage caused by shrinking and swelling of the soil. This soil has severe

limitations for septic tank absorption fields because of moderately slow permeability and depth to rock. It has moderate limitations for sewage lagoons because of depth to rock and slope. Deep, gently sloping, nearby soils, however, have only slight limitations for this use. This soil has a severe limitation for local roads and streets because of low strength. Strengthening or replacing the base material helps to overcome this limitation.

This soil is in capability subclass IVe.

Cc—Clime silty clay loam, 6 to 15 percent slopes. This moderately deep, well drained, strongly sloping soil is on uplands. It is on narrow ridgetops and on the escarpment below broad, gently sloping ridgetops. Individual areas are irregular in shape and range from 4 to more than 100 acres or more.

Typically, the surface layer is dark grayish brown silty clay loam about 9 inches thick. The subsoil is grayish brown, friable silty clay loam about 8 inches thick. The substratum is light brownish gray silty clay about 8 inches thick. Calcareous, clayey shale is at a depth of about 25 inches. In some places the surface layer is clay loam. Also in some places, channery shale and limestone fragments are on the surface and in the surface layer.

Included with this soil in mapping are small areas of shallow Sogn soils. The Sogn soils are on upper parts of slopes and make up 2 to 5 percent of the map unit.

Permeability is moderately slow in the Clime soil. Surface runoff is rapid, and available water capacity is low. This soil has moderate shrink-swell potential. It is calcareous and moderately alkaline throughout. Natural fertility is low. The rooting zone extends to clayey shale at a depth of 20 to 40 inches.

Most of this soil is used for rangeland. It has good potential for rangeland and fair potential for openland and rangeland wildlife habitat. It has poor potential for cultivated crops, pasture grasses, building site development, and sanitary facilities.

This soil is best suited to range. A major concern is the hazard of erosion. Management that maintains an adequate vegetative cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overgrazing reduces the protective vegetative cover and causes deterioration of the plant community. Under these conditions the more desirable grasses are replaced by less productive mid and short grasses and weeds. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has moderate limitations for dwellings because of slope and shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. This soil has severe limitations for septic tank absorption fields because of moderately slow permeability and depth to rock. It has a severe limitation for sewage lagoons because of slope. Onsite investigations should be considered to locate included or nearby, deep, gently sloping soils that are better suited to this use. This soil has a severe limitation for local roads and streets because of low strength. Strengthening or replacing the base material helps to overcome this limitation.

This soil is in capability subclass VIe.

Cd—Clime-Sogn complex, 5 to 20 percent slopes. This map unit consists of well drained and somewhat excessively drained, moderately deep and shallow soils on uplands (fig. 6). Individual areas are irregular in shape and range from 5 to 100 acres or more. They are 50 to 80 percent Clime soils and 10 to 30 percent Sogn soils. The Clime soils and Sogn soils are in alternate narrow bands that run along the contour of the slope. The Clime soils are 25 to 300 feet wide. The Sogn soils are in less sloping areas and are 10 to 100 feet wide.

Typically, the Clime soils have a surface layer that is dark grayish brown silty clay loam about 10 inches thick. The subsoil is grayish brown, friable silty clay loam about 9 inches thick. The substratum is light brownish gray silty clay about 8 inches thick. Calcareous, clayey shale is at a depth of about 27 inches. The soil is calcareous throughout. In some places the surface layer is silt loam or clay loam.

Typically, the Sogn soils have a surface soil that is dark gray silt loam about 14 inches thick. Hard limestone is at a depth of about 14 inches (fig. 7).

Included with these soils in mapping are small areas of deep Irwin soils and limestone outcrops. The Irwin soils are on lower slopes, and limestone outcrops are immediately below the Sogn soils.

Surface runoff is rapid on the soils in this complex. Permeability is moderately slow in the Clime soils and moderate in the Sogn soils. Clime soils have low available water capacity, and Sogn soils have very low available water capacity. The shrink-swell potential is moderate. The rooting zone extends to clayey shale at a depth of 20 to 40 inches in the Clime soils and extends to limestone at a depth of 4 to 20 inches in the Sogn soils. Natural fertility is low.

Most areas of these soils are used for rangeland. These soils have fair potential for range and fair to poor potential for rangeland wildlife habitat. They have poor potential for cropland, building site development, and sanitary facilities.

These soils are best suited to range. Major concerns are the hazard of erosion and droughtiness. Management that maintains an adequate vegetative cover and ground mulch helps to prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overgrazing reduces the protective vegetative cover and causes deterioration of the plant community. Under these conditions the more desirable grasses are replaced by less productive mid and short grasses and

weeds. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition. Brush management helps to improve the range where excessive grazing has caused brush and trees to invade. Sites that are well suited to stockwater ponds are common in this map unit.

Clime soils have moderate limitations for dwellings because of shrink-swell potential and slope. Sogn soils have a severe limitation because of depth to rock. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Onsite investigations should be considered to locate areas of moderately sloping Clime soils that are better suited to building sites.

Clime soils have severe limitations for septic tank absorption fields because of moderately slow permeability and depth to rock. Sogn soils have a severe limitation because of depth to rock. Clime soils have a severe limitation for sewage lagoons because of slope, and Sogn soils have severe limitations because of depth to rock and slope. If onsite sewage disposal is needed, areas of moderately sloping Clime soils are better suited to sewage lagoons.

Clime soils have a severe limitation for local roads and streets because of low strength, and Sogn soils have a severe limitation because of depth to rock. Where alternate routes are not available, road design needs to include measures to overcome the low strength and necessary provisions need to be made to excavate rock.

This complex is in capability subclass Vle.

Ce—Crete silty clay loam, 0 to 1 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad uplands. Individual areas are irregular in shape and range from 20 to 300 acres.

Typically, the surface layer is dark gray silty clay loam about 10 inches thick. The subsoil is about 33 inches thick. The upper part is dark grayish brown, friable silty clay loam; the middle part is brown and grayish brown, firm silty clay; and the lower part is brown, firm silty clay loam. The substratum to a depth of 60 inches is brown and light brownish gray silty clay loam.

In some places the upper part of the subsoil is dark gray silty clay. In a few places the substratum is brown silty clay.

Included with this soil in mapping are small areas of calcareous Clime soils around the upper end of small drainageways. These soils make up 2 to 5 percent of the unit.

Permeability and surface runoff are slow in the Crete soil. Available water capacity, shrink-swell potential, and natural fertility are high. The surface layer is friable and easily tilled.

Most areas of this soil are used for cropland. A few small areas are used for rangeland. The soil has good potential for cultivated crops, pasture, and rangeland. It has good potential for openland and rangeland wildlife habitat. It has fair potential for building site development and sanitary facilities.

This soil is well suited to small grains, sorghum, soybeans, and alfalfa and grasses for hay and pasture. Droughtiness is a hazard if these soils are cultivated. Returning crop residue to the soil helps to increase water infiltration, improve fertility, and reduce crusting. Using deep rooted legumes helps to improve the intake of water.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Uniform distribution of grazing, proper stocking rates, and deferred grazing help to keep the range in good condition.

This soil has a severe limitation for dwellings because of shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. This soil has a severe limitation for septic tank absorption fields because of slow permeability. Increasing the size of the absorption field helps to improve the functioning of septic tank systems. This soil is suited to sewage lagoons. It has severe limitations for local roads and streets because of low strength and shrink-swell potential. Strengthening or replacing the base material helps to overcome these limitations.

This soil is in capability subclass IIs.

Cf—Crete silty clay loam, 1 to 3 percent slopes. This deep, gently sloping, moderately well drained soil is on convex ridgetops and side slopes. Individual areas are irregular in shape and range from 15 to 1,000 acres or more.

Typically, the surface layer is dark gray silty clay loam about 8 inches thick. The subsoil is about 32 inches thick. The upper part is dark grayish brown, friable silty clay loam; the middle part is brown and grayish brown, firm silty clay; and the lower part is brown, firm silty clay loam. The substratum to a depth of 60 inches is brown and light brownish gray silty clay loam.

In some places the substratum is firm silty clay. In a few areas, most of the original surface layer has been eroded, and the present surface layer is dark grayish brown and more clayey.

Included with this soil in mapping are small areas of the moderately deep, calcareous Clime soil in similar positions on the landscape. This soil makes up 2 to 5 percent of the unit.

Surface runoff is medium, and permeability is slow in the Crete soil. Available water capacity is high. This soil has high shrink-swell potential and high natural fertility. The surface layer is friable and easily tilled.

Most areas of this soil are used for cropland. A few small areas are used for rangeland and tame grass pasture. This soil has good potential for cultivated crops, pasture, and rangeland. It has good potential for open-

land and rangeland wildlife habitat. It has fair potential for building site development and sanitary facilities.

This soil is well suited to small grains, sorghum, soybeans, alfalfa, and grasses for hay and pasture (fig. 8). If this soil is used for cultivated crops, erosion is a hazard. Minimum tillage, grassed waterways, terraces, and farming on the contour help to prevent excessive soil loss. Returning crop residue to the soil helps to increase water infiltration, improve fertility, and reduce crusting.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has a severe limitation for dwellings because of shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. This soil has a severe limitation for septic tank absorption fields because of slow permeability. Increasing the size of the absorption field helps to improve the functioning of septic tank systems. This soil has a moderate limitation for sewage lagoons because of slope. It has severe limitations for local roads and streets because of low strength and shrink-swell potential. Strengthening or replacing the base material helps to overcome these limitations.

This soil is in capability subclass IIe.

Cg—Crete silty clay loam, 3 to 7 percent slopes. This deep moderately well drained, moderately sloping soil is on convex side slopes. Individual areas are irregular in shape and range from 10 to 300 acres.

Typically, the surface layer is dark gray silty clay loam about 7 inches thick. The subsoil is about 31 inches thick. The upper part is dark grayish brown, friable silty clay loam; the middle part is brown and grayish brown, firm silty clay; and the lower part is brown, firm silty clay loam. The substratum to a depth of 60 inches is brown and light brownish gray silty clay loam. In a few places the substratum is firm silty clay. Also in a few areas, most of the original surface layer has been eroded, and the present surface layer is dark grayish brown and more clayey.

Included with this soil in mapping are small areas of Clime and Geary soils. The moderately deep, calcareous Clime soils and the less clayey Geary soils are on the upper parts of side slopes. These included soils make up 5 to 10 percent of the unit.

Surface runoff is medium, and permeability is slow in the Crete soil. Available water capacity and shrink-swell potential are high. The surface layer is friable and easily tilled. In eroded areas the surface layer forms a crust after hard rains. Natural fertility is medium.

Most of this soil is used for cropland. A few small areas are used for native range and tame pasture. The soil has good potential for cultivated crops, pasture, range, and rangeland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is well suited to small grains, sorghum, soybeans, and grasses and legumes for hay and pasture. Erosion is a hazard if this soil is used for cultivated crops. Minimum tillage, grassed waterways, terracing, and contour farming help to control erosion. Returning crop residue to the soil helps to increase water intake and maintain good tilth. Deep rooted legumes also help to improve water intake.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Uniform distribution of grazing, proper stocking rates, and deferred grazing help to keep the range in good condition.

This soil has a severe limitation for dwellings because of shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. This soil has a severe limitation for septic tank absorption fields because of slow permeability. Increasing the size of the absorption field helps to improve the functioning of septic tank systems. This soil has a moderate limitation for sewage lagoons because of slope. It has severe limitations for local roads and streets because of low strength and shrink-swell potential. Strengthening or replacing the base material helps to overcome these limitations.

This soil is in capability subclass IIIe.

Da—Detroit silt loam. This deep, nearly level, well drained soil is on the terrace of the Smoky Hill River. It is subject to rare flooding. Individual areas are irregular in shape and range from 60 to 2,000 acres or more.

Typically, the surface layer is dark gray silt loam about 8 inches thick. The subsurface layer is dark grayish brown, friable silty clay loam about 5 inches thick. The subsoil is about 32 inches thick. The upper part is dark grayish brown, firm silty clay loam; the middle part is brown, firm silty clay loam; and the lower part is grayish brown, firm, calcareous silty clay loam. The substratum to a depth of 60 inches is pale brown, calcareous silt loam. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Sutphen and McCook soils. The somewhat poorly drained Sutphen soils are in depressions. The less clayey McCook soils are near the flood plain. A few salt affected soils are in some areas. These included soils make up 5 to 10 percent of the unit.

Available water capacity and natural fertility are high in the Detroit soil. Permeability and surface runoff are slow. The surface layer is friable and easily tilled. This soil has high shrink-swell potential.

Nearly all of this soil is used for cropland. It has good potential for cultivated crops, pasture, and rangeland. It has good potential for openland, wetland, and rangeland

wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is well suited to small grains, sorghum, soybeans, and alfalfa and grasses for hay and pasture (fig. 9). It is well suited to irrigation development if good quality irrigation water is available (fig. 10). The main management concerns on this soil are maintenance of fertility and good tilth. Returning crop residue to the soil helps to improve fertility and tilth. Where silage crops or other crop residue is removed, soil blowing is a hazard. Planting wheat after the silage crop is removed helps to reduce soil blowing.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has severe limitations for dwellings because of flooding and shrink-swell potential. If houses are built on this soil, the sites need to be protected from flooding by dikes or levees. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. The soil has a severe limitation for septic tank absorption fields because of slow permeability. Increasing the size of the absorption field helps to improve the functioning of septic tank systems. This soil is suited to sewage lagoons. It has severe limitations for local roads and streets because of shrink-swell potential and low strength. Strengthening or replacing the base material helps to overcome these limitations.

This soil is in capability class I.

Ea—Elsmere fine sandy loam. This deep, nearly level, somewhat poorly drained soil is on bottom lands along small creeks that flow out of the sandhills. It is subject to rare flooding. Individual areas are irregular in shape and range from 30 to 160 acres.

Typically, the surface layer is dark gray fine sandy loam about 6 inches thick. The subsurface layer is dark gray, very friable fine sandy loam about 6 inches thick. The next layer is dark grayish brown, very friable loamy fine sand about 6 inches thick. The substratum to a depth of 60 inches is light brownish gray fine sand.

In some places the surface layer is loamy fine sand. Also, in a few places depth to a water table is more than 2.5 feet.

Included with this soil in mapping are small areas of Hobbs soil. The silty, well drained Hobbs soil is in similiar positions on the landscape. This soil makes up 10 to 15 percent of the unit.

Permeability is rapid, and surface runoff is slow on the Elsmere soil. Depth to the water table ranges from 1.5 to 2.5 feet during spring. This soil has low available water capacity and medium natural fertility. The surface layer is very friable and easily tilled.

About three-fourths of this soil is used for cropland. The rest is used for native range. This soil has good potential for rangeland, pasture, and openland and rangeland wildlife habitat. It has fair potential for cultivated crops. It also has poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, and alfalfa and well suited to grasses for hay and pasture. If this soil is used for cultivated crops, soil blowing and droughtiness are hazards. Stubble mulching helps to prevent soil blowing and reduce evaporation. Returning crop residue to the soil helps to increase water infiltration and improve fertility.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has severe limitations for dwellings with basements because of wetness and flooding. If alternate sites are not available, dwellings need to be designed to overcome the problems associated with a high water table; and the sites need to be protected from flooding. The soil has severe limitations for septic tank absorption fields because of wetness. If alternate sites are not available, onsite investigation should be considered to locate included soils that have a water table at a greater depth. Shallow ground water can be contaminated by seepage from absorption fields and lagoons. This soil has severe limitations for sewage lagoons because of wetness and seepage. Onsite investigation should be considered to locate included soils that have a water table at a greater depth and are not as limited by wetness. Sealing the lagoon helps to reduce seepage. This soil has moderate limitations for local roads and streets because of wetness, susceptibility to frost action, and flooding. If alternate sites are not available, special design is needed to overcome wetness and frost action, and the road sites need to be protected from flooding by dikes and levees.

This soil is in capability subclass IIw.

Fa—Fluvaquents, clayey. This map unit is located in abandoned channels of the Smoky Hill River. It consists of deep soils on the gently sloping, concave channel bottom and the moderately steep to vertical channel side slopes. The channel bottom is 160 to 350 feet wide and 5 to 15 feet below the adjacent flood plain or terrace. These soils are frequently flooded and are ponded much of the time. Individual areas range from one-eighth to 4 miles in length and from 5 to 80 acres in size.

The soils in this map unit are so variable that series classification was not practical. Typically, they are gray or dark gray stratified layers of calcareous silt loam, silty clay loam, silty clay, or clay to a depth of more than 60 inches. Clayey layers are at a depth of less than 20 inches. In some places the surface layer is grayish brown silt loam.

Included with these soils in mapping are small areas of poorly drained Solomon soils that are subject to less frequent ponding. Solomon soils make up 10 to 15 percent of the unit.

Permeability is slow in the Fluvaquents. Depth to the seasonal water table ranges from 0 to 2 feet, and most areas have a permanent water table within 6 feet of the surface. Water is ponded on many areas for several months each year, usually in spring and early in summer. These soils have poor structure and high shrink-swell potential.

The soils in this map unit are rarely managed for any use. They have fair potential for wetland wildlife habitat. They have poor potential for other uses unless major reclamation work is done. Some included areas of Solomon silty clay have fair potential for growing wheat and grain sorghum for wildlife habitat.

These soils are in capability subclass Vw.

Ga—Geary silt loam, 2 to 7 percent slopes. This deep, moderately sloping, well drained soil is on convex side slopes. Individual areas are irregular in shape and range from 7 to 1,200 acres or more.

Typically, the surface soil is grayish brown silt loam about 13 inches thick. The subsoil is about 39 inches thick. The upper part is brown, friable silty clay loam, and the lower part is reddish brown, firm silty clay loam. The substratum to a depth of 60 inches is light reddish brown silty clay loam with some lime concretions.

In eroded areas, plowing has mixed the original surface layer with material from the subsoil. The present surface layer is brown silty clay loam.

Included with this soil in mapping are small areas of the more clayey Crete and Irwin soils. The Crete soils are on the upper parts of gently sloping areas. The Irwin soils are on the upper parts of slopes. These soils make up 5 to 15 percent of the unit.

Permeability is moderately slow, and surface runoff is medium on the Geary soil. The surface soil is friable and easy to till. This soil has a moderate shrink-swell potential. Available water capacity and natural fertility are high.

Most areas of this soil are used for cropland. It has good potential for cultivated crops, pasture, and rangeland. It has fair potential for openland and rangeland wildlife habitat and for building site development and sanitary facilities.

This soil is well suited to wheat, sorghum, soybeans, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, erosion is a hazard. Minimum tillage, grassed waterways, terraces, and farming on the contour help to prevent excessive soil loss. Returning crop residue to the soil helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has a moderate limitation for dwellings because of shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. This soil has a severe limitation for septic tank absorption fields because of moderately slow permeability. Increasing the size of the absorption field helps to improve the functioning of septic tank systems. This soil has a moderate limitation for sewage lagoons because of slope. It has a severe limitation for local roads and streets because of low strength. Strengthening or replacing the base material helps to overcome this limitation.

This soil is in capability subclass IIIe.

Ha—Hobbs silt loam. This deep, nearly level, well drained soil is on the flood plain of creeks and small streams. It is subject to occasional flooding. Individual areas range from 200 to 1,000 feet in width and from 500 feet to three-fourths of a mile or more in length. They range from 4 to more than 60 acres in size.

Typically, the surface layer is dark gray silt loam about 8 inches thick. The substratum to a depth of 60 inches is dark grayish brown and dark gray silt loam.

In some places the surface layer is dark grayish brown silt loam and the upper part of the substratum is dark grayish brown silty clay loam.

Included with this soil in mapping are small areas of the more clayey Sutphen soils. The Sutphen soils are in depressional areas near the base of adjoining upland slopes. These soils make up 5 to 15 percent of the map unit.

Permeability is moderate, and surface runoff is slow on the Hobbs soil. Available water capacity and natural fertility are high. The surface layer is friable and easily tilled.

About one-half of this soil is used for cropland. The rest is mostly used for rangeland. This soil has good potential for cultivated crops, range, and pasture. It has good potential for openland and rangeland wildlife habitat and poor potential for building site development and sanitary facilities.

This soil is well suited to sorghum; soybeans; small grains; and alfalfa, grasses, and legumes for hay and pasture. Occasional flooding is a hazard if the soil is used for cropland (fig. 11). Dikes and diversions are useful in places for diverting damaging floodwaters. Flooding may be reduced by applying conservation measures upstream. Crops that produce sufficient residue can be grown continuously if the residue is returned to the soil. Minimum tillage and the use of crop residue help to improve fertility, maintain tilth, and increase water infiltration.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has severe limitations for dwellings, septic tank absorption fields, and sewage lagoons because of flooding. Alternate sites need to be selected for these uses. Protection from flooding by using dikes, levees, or other structures helps to overcome the limitations. This soil has severe limitations for local roads and streets because of flooding and low strength. Using dikes, levees, or other structures for flood protection and replacing or strengthening the base material help to overcome these limitations.

This soil is in capability subclass IIw.

Hb—Hobbs silt loam, channeled. This deep, nearly level soil has entrenched stream channels along intermittent drainageways (fig. 12). It is subject to frequent flooding. Individual areas range from about 165 to 500 feet in width, 600 to 5,000 feet in length, and 4 to 80 acres in size.

Typically, the surface layer is dark gray silt loam about 8 inches thick. The substratum to a depth of 60 inches is dark grayish brown and dark gray silt loam.

Included with this soil in mapping are small areas of Geary, Irwin, Muir, and Sutphen soils. Geary and Irwin soils are on side slopes. Muir and Sutphen soils are on stream terraces that are rarely flooded. These soils make up 10 to 15 percent of the unit.

Permeability is moderate and surface runoff is slow on the Hobbs soil. Available water capacity and natural fertility are high. The surface layer is friable, and tilth is good.

This soil is mostly used for rangeland and wildlife areas. It has good potential for range and pasture. It has fair potential for rangeland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is best suited to range and pasture. Most areas are overgrazed because they are near watering facilities and shade trees where livestock congregate. In overgrazed areas, the more desirable grasses are replaced by less productive mid and short grasses and weeds. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition. Potential pond sites are available on this soil.

This soil has severe limitations for and is generally unsuited to dwellings, septic tank absorption fields, and sewage lagoons because of flooding. Alternate sites need to be selected for these uses. This soil has severe limitations for local roads and streets because of flooding and low strength. Using dikes, levees, or other structures for flood protection and replacing or strengthening the base material help to overcome these limitations.

This soil is in capability subclass VIw.

Ia—Irwin silty clay loam, 1 to 3 percent slopes. This deep, gently sloping, moderately well drained soil is on convex ridgetops and side slopes. Individual areas are irregular in shape and range from 4 to 1,000 acres or more.

Typically, the surface layer is dark gray silty clay loam about 9 inches thick. The subsoil is firm silty clay about 30 inches thick. The upper part is dark grayish brown, the middle part is grayish brown, and the lower part is brown. The substratum to a depth of 60 inches is multicolored silty clay.

In some places the subsoil is browner, and the substratum is brown silty clay loam. Also in a few areas, most of the original surface layer has been eroded, and the present surface layer is dark grayish brown and more clayey.

Included with this soil in mapping are small areas of Clime soils. The moderately deep, calcareous Clime soils are along small intermittent drainageways and on low mounds. They make up 5 to 15 percent of the unit.

Permeability is very slow, and surface runoff is medium on the Irwin soil. Available water capacity is moderate, and shrink-swell potential is high. The surface layer is friable and easily tilled. In eroded areas the surface layer crusts after hard rains. Natural fertility is medium.

About three-fourths of this soil is used for cropland. The rest is mostly used for range and pasture. This soil has good potential for cultivated crops, range, and pasture. It has good potential for openland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is well suited to small grains, grain sorghum, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, erosion and drought are hazards. Minimum tillage, grassed waterways, terraces, and farming on the contour help to prevent excessive soil loss. Returning crop residue to the soil helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is well suited to range (fig. 13). In overgrazed areas the more desirable grasses are replaced by less productive mid and short grasses and weeds. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has a severe limitation for dwellings because of shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. This soil has a severe limitation for septic tank absorption fields because of very slow permeability. In places, it has a moderate limitation for sewage lagoons because of slope. The less sloping areas are the more favorable sites. This soil has severe limitations for local roads and streets because of shrink-swell potential and low strength. Strengthening or replacing the base material helps to overcome these limitations.

This soil is in capability subclass IIe.

Ib—Irwin silty clay loam, 3 to 7 percent slopes. This deep, well drained, moderately sloping soil is on convex side slopes (fig. 14). Areas of this soil commonly follow the slope, paralleling creeks and intermittent

drains. Individual areas are irregular in shape and range from 5 to 300 acres or more.

Typically, the surface layer is dark gray silty clay loam about 8 inches thick. The subsoil is firm silty clay about 28 inches thick. The upper part is dark grayish brown, the middle part is grayish brown, and the lower part is brown. The substratum to a depth of 60 inches is multicolored silty clay.

In some places the subsoil is browner and the substratum is brown silty clay loam. Also in a few areas, most of the original surface layer has been eroded, and the present surface layer is dark grayish brown and more clayey.

Included with this soil in mapping are small areas of the moderately deep, calcareous Clime soil. The Clime soil is on the upper parts of side slopes. It makes up 10 to 15 percent of the unit.

Permeability is very slow, and surface runoff is medium on the Irwin soil. This soil has moderate available water capacity and high shrink-swell potential. The surface layer is friable and easily tilled. In eroded areas the surface crusts after hard rains.

About one-half of this soil is used for cropland. The rest is mostly used for range and pasture. The soil has good potential for range and pasture. It has fair potential for cultivated crops and openland and rangeland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is moderately well suited to small grains, grain sorghum, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, erosion and droughtiness are hazards. Minimum tillage, grassed waterways, terraces, and farming on the contour help to prevent excessive soil loss. Returning crop residue to the soil helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has a severe limitation for dwellings because of shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. This soil has a severe limitation for septic tank absorption fields because of very slow permeability. It has a moderate limitation for sewage lagoons because of slope. Onsite investigations should be considered to locate nearby, less sloping areas that are better suited to this use. This soil has severe limitations for local roads and streets because of shrink-swell potential and low strength. Strengthening or replacing the base material helps to overcome these limitations.

This soil is in capability subclass IIIe.

La—Lancaster-Hedville loams, 3 to 15 percent slopes. This map unit consists of well drained and somewhat excessively drained, moderately deep and shallow, moderately sloping and strongly sloping soils on uplands (fig. 15). This map unit is 50 to 70 percent Lancaster soils and 15 to 35 percent Hedville soils. Hedville soils are on upper parts of slopes and Lancaster soils are on the lower parts of slopes. Individual areas are irregular in shape and range from 5 to 150 acres or more.

Typically, the Lancaster soils have a surface layer of dark grayish brown and brown loam about 11 inches thick. The subsoil is about 25 inches thick. The upper part is reddish brown, firm clay loam. The lower part is reddish yellow, friable sandy clay loam. Yellow, weathered sandy shale is at a depth of about 36 inches. In some places the surface layer is fine sandy loam or silt loam.

Typically, the Hedville soils have a loam surface soil about 13 inches thick. It is grayish brown in the upper part and dark brown in the lower part. The substratum is brown fine sandy loam about 3 inches thick. Brown and strong brown sandstone is at a depth of about 16 inches.

Included with these soils in mapping are small areas of the deep Irwin and Wells soils and sandstone outcrops. Irwin soils are on gently sloping areas. Wells soils are in concave areas near the lower part of the slope. These included soils make up about 5 to 15 percent of the unit.

Surface runoff is rapid, and permeability is moderate in the soils in this unit. Available water capacity is moderate in Lancaster soils and very low in Hedville soils. Effective rooting depth is 20 to 40 inches in Lancaster soils and less than 20 inches in Hedville soils. Lancaster soils have moderate shrink-swell potential, and Hedville soils have low shrink-swell potential. Natural fertility is medium to low.

Most areas of these soils are used for range. The soils have good potential for range and pasture. They have fair potential for rangeland and openland wildlife habitat. They have poor potential for cultivated crops and for building site development and sanitary facilities.

These soils are best suited to range. Major concerns are the hazard of erosion and droughtiness. Management that maintains an adequate vegetative cover and ground mulch helps to prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overgrazing reduces the protective vegetative cover and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive mid and short grasses and weeds. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition. Brush management helps to improve the range where excessive grazing has permitted brush and trees to invade.

This map unit has many sites where topography and relief are well suited to stockwater ponds. Many of these sites have a severe limitation for ponds because of seepage through sandy material and fractured bedrock.

Onsite investigations should be considered to locate sites with more clayey soils that are not subject to seepage. Also, using proper design helps to reduce seepage from ponds.

Lancaster soils have moderate limitations for dwellings without basements because of shrink-swell potential and slope. Hedville soils have a severe limitation because of depth to rock. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. Onsite investigations should be considered to locate areas of moderately sloping Lancaster soils that are better suited to building sites. Lancaster and Hedville soils have a severe limitation for septic tank absorption fields because of depth to rock. Lancaster soils have a severe limitation for sewage lagoons because of slope, and Hedville soils have severe limitations because of slope and depth to rock. If onsite sewage disposal is needed, the less sloping areas of Lancaster soils are more favorable sites for sewage lagoons. Lancaster soils have a severe limitation for local roads and streets because of low strength. Hedville soils have a severe limitation because of depth to rock. Where alternate routes are not available, road design needs to include measures to overcome the low strength and necessary provisions need to be made to excavate rock.

These soils are in capability subclass VIe.

Ma—McCook silt loam. This deep, nearly level, well drained soil is on the flood plain of the Smoky Hill River. It is commonly adjacent to the river channel and is subject to occasional flooding. Individual areas are irregular in shape and range from 10 to 600 acres.

Typically, the surface layer is gray, calcareous silt loam about 10 inches thick. The next layer is grayish brown, friable, calcareous silt loam about 7 inches thick. The substratum, to a depth of 60 inches is light brownish gray, calcareous silt loam in the upper part and light gray, calcareous very fine sandy loam in the lower part. In some places the surface layer is very fine sandy loam.

Included with this soil in mapping, and making up less than 5 percent of this unit, are Solomon soils. The clayey Solomon soils are poorly drained and in depressional areas of old meander scars.

Permeability is moderate, and surface runoff is slow on the McCook soil. Available water capacity is high. The surface layer is friable and easily tilled. This soil is calcareous and has high natural fertility.

Nearly all of this soil is used for cropland. It has good potential for cultivated crops, pasture, range, and openland and rangeland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is well suited to small grains, sorghum, soybeans, and grasses and legumes for hay and pasture. It is well suited to irrigation development if it is protected from flooding (fig. 16). Soil blowing and occasional flooding are hazards if this soil is used for cultivated crops. Stubble-mulch tillage helps to prevent soil blowing and increase water infiltration. A system of dikes and levees help to reduce crop and soil damage by floods.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has severe limitations for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets because of flooding. Protecting against flood damage by using dikes, levees, or other structures helps to overcome these limitations.

This soil is in capability subclass IIw.

Mb—Muir silt loam. This deep, nearly level, well drained soil is on stream terraces. It is subject to rare flooding. Individual areas range from 300 to 2,000 feet in width, one-eight of a mile to 2 miles or more in length, and 4 to 800 acres or more in size.

Typically, the surface layer is dark gray silt loam about 8 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsoil is about 33 inches thick. It is grayish brown, friable silt loam in the upper part and friable silty clay loam in the lower part. The substratum to a depth of 60 inches is grayish brown silty clay loam.

Included with this soil in mapping are small areas of Hobbs and Sutphen soils. The frequently flooded Hobbs soils are on lower bottom lands. The clayey Sutphen soils are in depressional areas. These soils make up 10 to 15 percent of the unit.

Surface runoff is slow, and permeability is moderate in the Muir soil. Available water capacity and natural fertility are high. The surface layer is friable and easily tilled.

Nearly all of this soil is used for cropland. This soil has good potential for cultivated crops, pasture, range, and openland and rangeland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is well suited to small grains, sorghum, soybeans, and grasses and legumes for hay and pasture. The main management concern is maintenance of fertility and good tilth. Soil blowing is a hazard if silage crops or other crop residue is removed. Returning crop residue to the soil helps to improve fertility and tilth. Stubble-mulch tillage helps to prevent soil blowing and increase water infiltration. A cover crop helps to reduce soil blowing on fields where crops have been harvested for silage.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has severe limitations for dwellings because of flooding. Using dikes or raising the site above flood level with fill material helps to protect dwellings from flooding. The soil has a moderate limitation for septic tank absorption fields because of flooding. If alternate sites are not available, the sites need to be protected from flooding. The soil has a moderate limitation for

sewage lagoons because of seepage. Sealing the lagoon helps to reduce seepage. This soil has a severe limitation for local roads and streets because of low strength. Strengthening or replacing the base material helps to overcome this limitation.

This soil is in capability class I.

Oa—Ortello-Wells fine sandy loams, undulating. This map unit consists of deep, well drained soils on undulating uplands (fig. 17). Ortello soils make up 40 to 60 percent of the map unit and Wells soils make up 25 to 45 percent. The Ortello and Wells soils are so intricately mixed on the landscape that it is not practical to separate them in mapping. Ortello soils are on lower parts of slopes, and Wells soils are on upper parts of slopes. The ratio of Ortello soils to Wells soils is commonly greater in the areas near the Smoky Hill River Valley than it is in the areas farther from the valley. Individual areas are irregular in shape and range from 10 to 900 acres.

Typically, Ortello soils have a grayish brown fine sandy loam surface layer about 8 inches thick. The subsurface layer is grayish brown, very friable fine sandy loam about 8 inches thick. The subsoil is brown, very friable fine sandy loam about 19 inches thick. The substratum to a depth of 60 inches is brown fine sandy loam and loamy fine sand.

Typically, Wells soils have a dark gray fine sandy loam surface layer about 8 inches thick. The subsurface layer is brown, friable loam about 4 inches thick. The subsoil is about 32 inches thick and is brown, friable loam in the upper part. The middle part is strong brown, friable sandy clay loam, and the lower part is light brown, friable sandy clay loam. The substratum to a depth of 60 inches is strong brown sandy loam. In some eroded areas, plowing has mixed material from the subsoil with the original surface layer, and the present surface layer is brown loam.

Included with these soils in mapping are small areas of the more clayey, somewhat poorly drained Carwile soils. Carwile soils are in small depressions and make up 5 to 10 percent of the unit.

Surface runoff is medium in the Ortello and Wells soils. Ortello soils have moderately rapid permeability, and Wells soils have moderate permeability. Ortello soils have moderate available water capacity, and Wells soils have high available water capacity. Ortello soils have low shrink-swell potential, and Wells soils have moderate shrink-swell potential. The surface layer of these soils is friable or very friable and easily tilled. Natural fertility is medium.

About 60 percent of this map unit is used for cropland. The rest is mostly used for range. These soils have good potential for range and for openland and rangeland wildlife habitat. They have fair potential for cultivated crops and pasture. They have good potential for building site development and sanitary facilities.

These soils are moderately well suited to small grains, sorghums, grasses and legumes for hay and pasture, and melons and other specialty crops. Soil blowing and droughtiness are hazards where these soils are cultivated. Stubble-mulch tillage and cover cropping help to reduce soil blowing and improve the moisture supplying capacity by reducing runoff in the moderately sloping areas. Stripcropping and planting windbreaks also help to reduce soil blowing.

These soils are well suited to range. They are susceptible to soil blowing if the plant cover is removed by excessive grazing. Overgrazing reduces the protective vegetative cover and causes deterioration of the plant community. Under these conditions, the desirable grasses are replaced by less productive mid and short grasses and weeds. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition. Only a limited number of sites that are well suited to stockwater ponds are in this map unit.

Ortello soils have slight limitations for dwellings, and Wells soils have a moderate limitation for this use because of shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil. Ortello soils have slight limitations for septic tank absorption fields. Wells soils have a moderate limitation for septic tank absorption fields because of moderate permeability. Increasing the size of the absorption field in areas of the Wells soils helps to improve the functioning of the septic tank system. Ortello soils have a severe limitation for sewage lagoons because of seepage. Wells soils have moderate limitations because of seepage and slope. Sealing the lagoon helps to reduce seepage. Ortello soils have a moderate limitation for local roads and streets because of frost action. Wells soils have a severe limitation because of low strength. Strengthening or replacing the base material helps to overcome these limitations.

These soils are in capability subclass IIIe.

Qa—Quarries. This miscellaneous land type consists of limestone quarries from which the soil and much of the underlying limestone and shale has been removed. The underlying material has been removed for the production of agricultural lime, road gravel, and building stone. Quarries that do not have drainage can be filled with water for short periods. Individual areas range from 4 to 200 acres.

Recently quarried areas are barren. Older areas can have scattered trees, brush, or grass.

This map unit has limited potential for agricultural, engineering, and recreational uses without major reclamation work. Some areas have fair potential for wildlife uses.

This map unit is in capability subclass VIIIs.

Sb—Solomon silty clay. This deep, nearly level, poorly drained soil is on the flood plain of the Smoky Hill River. It is in depressions of old meander scars and is subject to occasional flooding. Individual areas range from 165 to 1,400 feet or more in width, from 900 to 6,000 feet in length, and from 4 to 200 acres in size.

Typically, the surface layer is dark gray, calcareous silty clay about 10 inches thick. The subsoil is very firm, calcareous silty clay about 35 inches thick. The upper part is dark gray, and the lower part is gray. The substratum to a depth of 60 inches is gray, calcareous silty clay.

Included with this soil in mapping are small areas of the less clayey McCook soil on convex slopes. This soil makes up 5 to 10 percent of this unit.

Permeability and surface runoff are very slow in the Solomon soil. Water ponds on the surface in some places. Depth to the seasonal water table ranges from 0 to 2 feet. This soil has moderate available water capacity. Shrink-swell potential is high. The soil is sticky when wet, very hard when dry, and difficult to till. Natural fertility is medium.

Most of this soil is used for cropland. It has good potential for range, pasture, and wetland wildlife habitat. It has fair potential for cultivated crops and poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghums, soybeans, and grasses for hay and pasture. If this soil is cultivated, wetness is a hazard in spring and early in summer and droughtiness is a hazard late in summer (fig. 18). The soil is difficult to till. Using a system of open ditches, where outlets are available, helps to improve surface drainage and reduce wetness. Returning crop residue to the soil helps to improve the moisture supplying capacity by increasing water infiltration. Returning crop residue to the soil also helps to improve fertility and tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has severe limitations for dwellings because of flooding, wetness, and shrink-swell potential; for septic tank absorption fields because of flooding, wetness, and very slow permeability; for sewage lagoons because of flooding and wetness; and for local roads and streets because of flooding, wetness, and low strength. It is generally unsuited to all of these uses. Alternate sites that are more favorable for these uses should be considered.

This soil is in capability subclass IIIw.

Sc—Sutphen silty clay loam. This deep, nearly level, moderately well drained soil is on the terrace of large creeks and the Smoky Hill River. It is subject to occasional flooding. Individual areas are irregular in shape and range from 5 to 400 acres.

Typically, the surface layer is dark gray silty clay loam about 12 inches thick. The subsurface layer is very dark gray, very firm silty clay about 14 inches thick. The next layer is dark gray, very firm silty clay about 8 inches thick. The substratum to a depth of 60 inches is grayish brown silty clay and brown silty clay loam containing lime concretions. In a few places the surface layer is silty clay. Also, the soil is calcareous throughout in a few places.

Included with this soil in mapping are small areas of the less clayey Muir soil on convex slopes. This soil makes up 5 to 10 percent of this unit.

Permeability is very slow, and surface runoff is slow on the Sutphen soil. This soil has moderate available water capacity and high shrink-swell potential. Natural fertility is high.

Most of this soil is used for cropland. It has good potential for cultivated crops, range, and pasture. It has fair potential for openland and wetland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is well suited to small grains, sorghum, soybeans, and grasses and legumes for hay and pasture. The main management concern on this soil is maintenance of fertility and good tilth. Returning crop residue to the soil helps to improve fertility, reduce crusting, maintain tilth, and improve moisture supplying capacity by increasing water infiltration.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has severe limitations for dwellings because of flooding and shrink-swell potential; for septic tank absorption fields because of flooding and very slow permeability; and for sewage lagoons because of flooding. Alternate sites need to be selected for these uses. Protection from flooding by using dikes, levees, or other structures reduces the hazard. This soil has severe limitations for local roads and streets because of flooding, shrink-swell potential, and low strength. Strengthening or replacing the base material and protecting the areas from flooding by dikes, levees, or other structures help to overcome these limitations.

This soil is in capability subclass IIw.

Sd—Sutphen silty clay. This deep, nearly level, somewhat poorly drained soil is on the terrace of the Smoky Hill River and large creeks. It is typically in slightly depressed areas on the terrace and is subject to occasional flooding. Individual areas are irregular in shape and range from 4 to 600 acres.

Typically, the surface layer is dark gray silty clay about 7 inches thick. The subsurface layer is very dark gray, very firm silty clay about 17 inches thick. The next layer is dark gray, very firm silty clay about 8 inches thick. The substratum to a depth of 60 inches is grayish brown silty

clay and brown silty clay loam containing soft accumulations of lime. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of the less clayey, well drained Muir and Detroit soils. These soils are on slightly higher areas. They make up 5 to 15 percent of the unit.

Permeability is very slow, and surface runoff is slow on the Sutphen soil. This soil has high shrink-swell potential. Available water capacity is moderate. The soil is sticky when wet, very hard when dry, and difficult to till. Natural fertility is medium.

Most of this soil is used for cropland. It has good potential for range and pasture. It has fair potential for cultivated crops and openland and wetland wildlife habitat. It has poor potential for building site development and sanitary facilities.

This soil is moderately well suited to wheat, sorghum, soybeans, and grasses and legumes for hay and pasture. If this soil is cultivated, wetness is a hazard in spring and droughtiness is a hazard late in summer. This soil is difficult to till. Using a system of open ditches, where outlets are available, helps to improve surface drainage and reduce wetness. Returning crop residue to the soil helps to increase water infiltration and improve fertility and tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has severe limitations for dwellings because of flooding and shrink-swell potential, for septic tank absorption fields because of flooding and very slow permeability, and for sewage lagoons because of flooding. Alternate sites need to be selected for these uses. Protection from flooding by using dikes, levees, or other structures reduces this hazard. This soil has severe limitations for local roads and streets because of flooding, shrink-swell potential, and low strength. Strengthening or replacing the base material and protecting the areas from flooding by using dikes, levees, or other structures help to overcome these limitations.

This soil is in capability subclass IIIw.

Va—Valentine loamy fine sand, rolling. This deep, excessively drained soil is on uplands (fig. 19). Individual areas are irregular in shape and range from 4 to 320 acres.

Typically, the surface layer is grayish brown loamy fine sand about 7 inches thick. The next layer is brown, very friable loamy fine sand about 8 inches thick. The substratum to a depth of 60 inches is light yellowish brown loamy fine sand. In some places the surface layer and the layer below it are fine sandy loam.

Included with this soil in mapping are small areas of Carwile, Elsmere, and Wells soils. The somewhat poorly drained Carwile and Elsmere soils are in depressions. The well drained Wells soils are on upper parts of slopes. These included soils make up 5 to 10 percent of the unit.

Surface runoff is slow, and permeability is rapid in the Valentine soil. This soil has a low available water capacity. Natural fertility is also low.

Most of this soil is used for range. It has good potential for range and fair potential for openland and rangeland wildlife habitat. It has fair potential for building site development and sanitary facilities.

This soil is best suited to range. It is highly susceptible to soil blowing if the plant cover is removed. Overgrazing reduces the protective vegetative cover and causes deterioration of the plant community. Under these conditions, the desirable grasses are replaced by less productive mid and short grasses and weeds. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition. Potential pond reservoir sites are limited on this soil.

This soil has moderate limitations for dwellings and septic tank absorption fields because of slope. It has severe limitations for sewage lagoons because of seepage and slope. Seepage from lagoons and septic tank absorption fields can contaminate shallow ground water. Sealing lagoons helps to overcome seepage. This soil has moderate limitations for local roads and streets because of slope.

This soil is in capability subclass VIe.

Vb—Valentine loamy fine sand, undulating. This deep, excessively drained soil is on uplands (fig. 20). Individual areas are irregular in shape and range from 20 to 1,000 acres.

Typically, the surface layer is grayish brown loamy fine sand about 7 inches thick. The next layer is brown, very friable loamy fine sand about 8 inches thick. The substratum to a depth of 60 inches is light yellowish brown loamy fine sand. In some places the surface layer and subsoil are fine sandy loam.

Included with this soil in mapping are small areas of finer textured Wells, Carwile, and Elsmere soils. The Wells soils are more common in areas near the northern fringe of the sandy uplands. The Carwile and Elsmere soils are somewhat poorly drained and are in low areas and depressions. These included soils make up less than 15 percent of the map unit.

Permeability is rapid in the Valentine soil. Surface runoff is slow. This soil has low available water capacity. Natural fertility is also low.

About two-thirds of this soil is used for range, and the rest is mostly used for cropland. This soil has good potential for range. It has fair potential for cultivated crops and openland and rangeland wildlife habitat. This soil has good potential for building site development and sanitary facilities.

This soil is moderately well suited to small grains, grain sorghum, grasses for hay and pasture, and a few

specialty crops. Soil blowing and droughtiness are hazards if this soil is cultivated. Stubble-mulch tillage, cover cropping, stripcropping, and planting windbreaks help to reduce soil blowing. Returning crop residue to the soil helps to improve fertility and increase the water holding capacity.

This soil is moderately well suited to range. Overgrazing reduces the vigor and growth of the grasses. The soil is highly susceptible to blowing if the plant cover is removed by overgrazing. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil is suited to dwellings, septic tank absorption fields, and local roads and streets. It has severe limitations for sewage lagoons because of seepage. Seepage from septic tank absorption fields and sewage lagoons may contaminate shallow ground water. Sealing lagoons helps to reduce seepage.

This soil is in capability subclass IVe.

Wa—Wells loam, 3 to 7 percent slopes. This deep, moderately sloping well drained soil is on convex to slightly concave upland slopes. Individual areas are irregular in shape and range from 5 to 500 acres or more.

Typically, the surface layer is dark gray loam about 8 inches thick. The subsurface layer is brown, friable loam about 4 inches thick. The subsoil is about 32 inches thick and is brown, friable loam in the upper part; strong brown, friable sandy clay loam in the middle part; and light brown, friable sandy clay loam in the lower part. The substratum to a depth of 60 inches is strong brown sandy loam. In some places the surface layer is fine sandy loam.

Included with this soil in mapping are small areas of Lancaster and Hedville soils. Moderately deep Lancaster soils and shallow Hedville soils are on upper parts of side slopes. These soils make up 10 to 15 percent of this unit.

This Wells soil has moderate permeability and medium surface runoff. It has high available water capacity and moderate shrink-swell potential. Natural fertility is medium.

About two-thirds of this soil is used for range. The rest is mostly used for cropland. This soil has good potential for range, pasture, and cultivated crops. It has good potential for openland wildlife habitat. It has fair potential for building site development and sanitary facilities.

This soil is well suited to small grains, sorghum, soybeans, and grasses and legumes for hay and pasture. There is a hazard of erosion if the soil is used for cultivated crops. Minimum tillage, grassed waterways, terraces, and farming on the contour help to prevent excessive soil loss. Returning crop residue to the soil helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is well suited to range. Overgrazing causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive mid and short grasses and weeds. Proper stocking rates, uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil has a moderate limitation for dwellings because of shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help to prevent structural damage caused by shrinking and swelling of the soil.

This soil has a moderate limitation for septic tank absorption fields because of moderate permeability. Increasing the size of the absorption field helps to improve the functioning of septic tank systems. This soil has moderate limitations for sewage lagoons because of seepage and slope. Sealing the lagoon helps to reduce seepage. This soil has a severe limitation for local roads and streets because of low strength. Strengthening or replacing the base material helps to overcome this limitation.

This soil is in capability subclass IIIe.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and

on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, and trees are influenced by the nature of the soil.

Crops and pasture

Earl J. Bondy, agronomist, Soil Conservation Service, assisted in preparing this section.

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

Approximately 65 percent of the total acreage in Dickinson County was used for crops in 1967 (*4*). During the last ten years, ending in 1975, wheat was produced on approximately 51 percent of the cropland. Sorghum was produced on 29 percent and alfalfa on 9 percent. Corn, oats, barley, and soybeans constitute minor acreages in the county.

The acreage of sorghum has almost doubled over the past 10 years as compared to the previous 10 years. The acreage of soybeans has more than doubled but still consists of only 1 percent of the total crop production. Wheat has increased 5 percent. All other crops have decreased in acreage.

On cultivated soils in Dickinson County, it is important to control erosion; to preserve fertility, tilth, and organic matter; and to conserve moisture and maintain desirable soil drainage.

Erosion is the major problem on 75 percent of the cropland in Dickinson County. Where the slope is more than 1 percent, erosion is a hazard. Irwin and Crete are the principal soils used for crops in the county.

Loss of the surface layer through erosion is damaging for two reasons. First—productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as, Irwin and Crete soils. Second—erosion results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps plant cover on the soil for extended periods reduces erosion and preserves the productive capacity of the soils.

Terraces and diversions reduce the length of slopes and reduce runoff and erosion. They are most practical on deep, well drained soils that have uniform, regular slopes. Irwin silty clay loam, 3 to 7 percent slopes, is an example of a soil that can use terraces and diversions effectively.

Contour tillage generally needs to be used in combination with terraces. Contour tillage is best suited to those soils that have smooth, uniform slopes and are suitable for terracing. Crete silty clay loam, 3 to 7 percent slopes, is an example of a soil on which tilling on the contour helps to reduce water erosion.

All cultivated soils in the county need fertilizer. Nitrogen is generally the largest amount needed. The amount of fertilizer used should be based on soil tests and related information from the Kansas Agricultural Experiment Station.

A soil in good tilth can be easily tilled, provides a good seedbed, and allows easy seedling emergence and root penetration. Leaving crop residue in the field to be returned to the soil helps to maintain good tilth and organic matter content. Minimum tillage prevents some soil compaction and helps to maintain good tilth.

Leaving crop residue on the surface, either by minimum tillage or stubble mulching, helps to increase infiltration, conserve moisture, and reduce runoff and the hazard of erosion. The extra cover is essential to help prevent wind erosion. These practices help to maintain or improve the condition of all cultivated soils in the county.

Information on the design of erosion control practices is available in the local offices of the Soil Conservation Service. The latest information and suggestions for growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. The capability class and subclass levels are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability subclass is identified in the description of each soil map unit in the section "Soil maps for detailed planning."

Rangeland

Kenneth L. Hladek, range conservationist, Soil Conservation Service, assisted in preparing this section.

Approximately 27 percent of Dickinson County, or 140,135 acres, is in rangeland. This compares, however, to slightly more than 38 percent of the agricultural product value of the county being derived from livestock, principally cattle.

Many of the livestock operations in Dickinson County are composed of small stock farm type units. This is particularly true in the central half of the county where small acreages of rangeland are interspersed between larger units of cropland. Larger ranch type operations prevail in the northern and southern sections of the county where rangeland areas tend to occur in larger and more continuous tracts.

Some livestock producers extend their grazing season by using of cool season tame grass pasture, principally bromegrass. Many operators also supplement their grassland forages by grazing grain sorghum crop residue and occasionally small grain winter pasture. During the winter months, livestock on rangeland are usually given a supplement of hay and protein concentrates.

Soils strongly influence the potential natural plant community for any given area within the county. The soils and precipitation received can support a Tall Grass Prairie plant community dominated by the bluestems (*Andropogon*), switchgrass (*Panicum virgatum*), and indiangrass (*Sorghastrum nutans*). Because of the strong influence of sandy soils, a small acreage of Sand Prairie can be supported between Abilene and Solomon and northeast of Abilene. These tall grass prairies are potentially dominated by the bluestems, indiangrass, and reedgrass.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 6 shows, for each kind of soil, the name of the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community of predominately grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in table 6.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegetation has been established, range sites can be interpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production refers to the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife.

Characteristic species of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed by common name. Under *Composition*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

One of the major concerns of rangeland management is the control of grazing so that the major plant species of the natural plant community are either maintained or improved. Forage production has been reduced on many areas because the natural plant community has been depleted by excessive, continuous grazing. Proper grazing and good grazing distribution are two practices

needed to maintain the rangeland in the county. Range improvement can be accomplished by grazing deferment, using systems of planned grazing, weed and brush control, and reseeding of abandoned cropland.

Sound range management, based on soil survey information and other inventory data, is the basis for maintaining or improving forage production on the county's rangeland.

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Table 7 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 7, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Engineering

Franklin C. Kinsey, civil engineer, Soil Conservation Service, assisted in preparing this section.

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 8 shows, for each kind of soil, the degree and kind of

limitations for building site development; table 9, for sanitary facilities; and table 11, for water management. Table 10 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 8. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 8 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 8 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 9 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for

this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 9 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 10 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in

table 14 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 10 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Major conservation engineering practices in Dickinson County deal with problems of controlling gully and sheet erosion, stabilizing stream and channel gradients, and maintaining water supplies. Many of these limitations can be overcome by good water management. Some common practices used in Dickinson County in managing water include waterways, terraces, diversions, and dams. Farm ponds are used extensively to furnish water for livestock, recreation, wildlife, and other uses. Water for livestock is also furnished by springs and wells.

Other limitations are drainage, flood control, pollution abatement, and conservation of irrigation water. Practices used for the solution and control of these limitations are open-ditch surface and tile subsurface drainage systems, floodwater retarding dams, agricultural waste management systems, and irrigation water management systems.

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 11 soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water

capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, assisted in preparing this section.

Dickinson County has several areas of scenic, geologic, and historic significance. Several watershed lakes, farm ponds, and the Smoky Hill River and its tributaries provide opportunities for water-based recreation on privately-owned land. This county has fair to good potential for additional recreation development.

The soils of the survey area are rated in table 12 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 12 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 9, and interpretations for dwellings without basements and for local roads and streets, given in table 8.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

Robert J. Higgins, biologist, Soil Conservation Service, assisted in preparing this section.

The main game species in Dickinson County are pheasant, bobwhite quail, mourning dove, cottontail, fox squirrel, white-tailed deer, and several species of waterfowl.

Nongame species of wildlife within the county are numerous because of the diverse habitat types. Cropland, woodland, and grassland are interspersed throughout the county creating the desirable edge effect that is conducive to attracting many species. Each of these habitat types provides a home for a particular group of species.

Furbearers are sparse to common along the Smoky Hill River and its tributaries. Trapping is done on a limited basis.

Stockwater ponds, streams, and watershed lakes provide good to excellent fishing. Species commonly found in the county are bass, channel cat and flathead catfish, carp, and bluegill.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 13, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are grain sorghum, wheat, oats, barley, and soybeans.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestems, switchgrass, Indiangrass, goldenrod, ragweed, wheatgrass, native legumes, and grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are wild current, dogwood, buckbrush, prairie rose, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, saltgrass, and prairie cordgrass, indigo bush and rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, redwing blackbird, muskrat, mink, and beaver.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include jack rabbits, hawks, badgers, dickcissels, white-tailed deer, mule deer, and meadowlarks.

Developing a specific habitat for wildlife requires that the plant cover is the kind that the soils can produce and that it is properly located. Onsite technical assistance in planning wildlife areas and in determining suitable species of vegetation for planting can be obtained from the Soil Conservation Service, Kansas Fish and Game Commission, and the Extension Service.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 14 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 14 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 14 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 14. Also in table 14 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 15 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 15. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly

erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 16 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of

excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Engineering test data

The results of analyses of engineering properties of several typical soils of the survey area are given in table 17.

The data presented are for soil samples that were collected from carefully selected sites. The soil profiles sampled are typical of the series discussed in the section "Soil series and morphology." The soil samples were analyzed by the Kansas Department of Transportation.

The methods used in obtaining the data are listed by code in the next paragraph. Most of the codes, in parentheses, refer to the methods assigned by the American Association of State Highway and Transportation Officials. The codes for shrinkage, Unified classification, and California bearing ratio are those assigned by the American Society for Testing and Materials.

The methods and codes are AASHTO classification (M-145-66); Unified classification (D-2487-69); grain size distribution (T88-72); liquid limit (T89-68); plasticity index (T90-70); moisture-density, method A (T99-74).

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*3*). Unless otherwise noted, matrix colors described are for dry soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Carwile series

The Carwile series consists of deep, somewhat poorly drained, slowly permeable soils on plane to concave uplands. These soils formed in old alluvium and eolian sediment. Slopes are 0 to 1 percent.

These soils are taxadjuncts to the Carwile series because they are in a cooler temperature regime than is defined for the series. This difference does not significantly alter their behavior and usefulness.

Carwile soils are commonly adjacent to Ortello, Valentine, and Wells soils on the landscape. Ortello and Valentine soils contain more sand in all horizons, have steeper slopes, and are above the Carwile soils. Wells soils are well drained, have steeper slopes, and are above the Carwile soils.

Typical pedon of Carwile loam, 1,270 feet north and 65 feet west of the SE corner of sec. 3, T. 13 S., R. 1 E.:

A11—0 to 7 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, friable; medium acid; clear smooth boundary.

A12—7 to 14 inches; dark gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) moist; moderate fine granular structure; hard, friable; medium acid; clear smooth boundary.

B21t—14 to 21 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; few fine distinct reddish yellow (7.5YR 6/6) mottles; moderate fine and medium blocky structure; very hard, firm; slightly acid; clear smooth boundary.

B22t—21 to 31 inches; light gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; weak fine distinct yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; very hard, firm; slightly acid; clear smooth boundary.

C—31 to 38 inches; light gray (10YR 7/1) clay loam, gray (10YR 5/1) moist; few fine distinct brownish

yellow (10YR 6/6) mottles; massive; hard, firm; neutral; abrupt smooth boundary.

Ab—38 to 46 inches; dark gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) moist; common fine prominent reddish brown (5YR 4/4) mottles; massive; very hard, firm; moderately alkaline; gradual smooth boundary.

Bb—46 to 60 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; thin strata of light brownish gray (10YR 6/2) sand; common fine prominent reddish brown (5YR 4/4) mottles; massive; very hard, firm; moderately alkaline.

The solum is 30 to 45 inches thick. The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly loam, but the range includes fine sandy loam or clay loam. Reaction ranges from medium acid to neutral. The B2t horizon has hue of 10YR or 2.5Y, value of 5 to 7 (3 to 5 moist), and chroma of 1 or 2. It is clay loam or clay. The C horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 6 to 8 (4 to 6 moist); and chroma near 1. It is fine sandy loam, clay loam, or clay. It ranges from neutral to moderately alkaline. In a few places, the C horizon contains lime concretions below a depth of 30 inches. Some pedons do not have buried horizons at a depth of less than 60 inches.

Clime series

The Clime series consists of moderately deep, well drained soils on uplands. These soils have moderately slow permeability. They formed in material weathered from calcareous, clayey shale. Slopes are 2 to 20 percent.

Clime soils are similar to Lancaster soils and are commonly adjacent to Crete, Irwin, and Sogn soils in the landscape. Lancaster soils have an argillic horizon and do not have free lime. The deep Crete soils are on slopes and broad uplands above the Clime soils. The deep Irwin soils have a silty clay B2t horizon. The shallow Sogn soils are in alternate narrow bands with Clime soils in the same landscape.

Typical pedon of Clime silty clay loam, from an area of Clime-Sogn complex, 5 to 20 percent slopes, 700 feet west and 120 feet south of the NE corner of sec. 24, T. 13 S., R. 3 E.:

A1—0 to 5 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; hard, friable; moderately alkaline; clear smooth boundary.

A3—5 to 10 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; strong effervescence; 2 percent limestone fragments less than 1/2 inch in diameter; moderately alkaline; gradual smooth boundary.

B2—10 to 19 inches; grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate fine and medium granular structure; hard, friable; strong effervescence; moderately alkaline; clear smooth boundary.

C—19 to 27 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; moderate very fine subangular blocky structure; very hard, firm; violent effervescence; moderately alkaline; gradual smooth boundary.

Cr—27 inches; light gray (5Y 7/2) calcareous clayey shale.

The solum is 12 to 27 inches thick, and depth to shale bedrock is 20 to 40 inches. Free carbonates are disseminated throughout the soil mass in most pedons and at a depth of less than 10 inches in all pedons. Channery limestone fragments are on the surface and in the A horizon of some pedons.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is mildly alkaline or moderately alkaline. The B2 horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 1 to 3. In some pedons the lower part of the B2 horizon is mixed with soil material that is the color of the adjoining C horizon. The C horizon has hue of 10YR, 2.5Y or 5Y; value of 5 to 7 (4 to 6 moist); and chroma of 2 to 4.

Crete series

The Crete series consists of deep, somewhat poorly drained and moderately well drained, slowly permeable soils on loess covered uplands. These soils formed in loess. Slopes are 0 to 7 percent.

Crete soils are similar to Detroit and Irwin soils and are commonly adjacent to Clime, Geary, and Irwin soils in the landscape. Detroit soils have a silty clay loam B2t horizon and are on river terraces. Irwin soils have a silty clay C horizon and are on slopes below the Crete soils. The moderately deep Clime soils are on side slopes below the Crete soils. Geary soils have a silty clay loam B2t horizon and are on side slopes below the Crete soils.

Typical pedon of Crete silty clay loam, 1 to 3 percent slopes, 1,810 feet north and 250 feet east of the SW corner of sec. 16, T. 12 S., R. 2 E.:

Ap—0 to 8 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; weak fine granular structure; hard, friable; medium acid; clear smooth boundary.

B1—8 to 11 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate very fine subangular blocky struc-

ture and moderate fine granular; hard, friable; slightly acid; clear smooth boundary.

B21t—11 to 21 inches; brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; moderate fine blocky structure; very hard, firm; slightly acid; clear smooth boundary.

B22t—21 to 30 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate fine blocky structure; very hard, firm; slightly acid; clear smooth boundary.

B3ca—30 to 40 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate fine and medium blocky structure; very hard, firm; few fine very dark brown concretions; lime concretions are common; mildly alkaline; gradual smooth boundary.

C1—40 to 55 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; few, fine, faint strong brown (7.5YR 5/6) mottles; weak medium blocky structure; very hard, firm; few fine very dark brown concretions; few lime concretions in upper part of the horizon; mildly alkaline; gradual smooth boundary.

C2—55 to 60 inches; mottled light brownish gray (10YR 6/2) and brown (7.5YR 5/4) silty clay loam, dark grayish brown (10YR 4/2) moist and dark brown (10YR 4/3) moist; massive; very hard, firm; few, fine very dark brown concretions; mildly alkaline.

The solum is 30 to 48 inches thick. The mollic epipedon is 20 to 36 inches thick and includes all of the A horizon and the upper part of the B horizon. Most pedons contain lime concretions at some depth between 25 and 40 inches, but the soil mass above a depth of 40 inches is noncalcareous.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is medium acid or slightly acid. The B horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. The lower part of the B horizon, in places, has value of 6 (5 moist). The B horizon is slightly acid or neutral in the upper part and slightly acid to mildly alkaline in the lower part. The C horizon has hue of 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 2 or 3. The C horizon, in places, has a few yellowish brown, yellowish red, or strong brown mottles.

Detroit series

The Detroit series consists of deep, well drained, slowly permeable soils on river terraces. These soils formed in calcareous silty alluvium. Slopes are 0 to 1 percent.

Detroit soils are similar to Crete and Muir soils and are commonly adjacent to McCook, Solomon, and Sutphen soils in the landscape. Crete soils have a silty clay B2t horizon and are on uplands. Muir soils have a less clayey subsoil and are on creek terraces. McCook soils do not have a B2t horizon, contain less clay, and are on adjacent flood plains. The poorly drained Solomon soils are silty clay in all horizons and are in depressions of adjacent flood plains. Sutphen soils are more poorly drained, contain more clay, and are in low areas on terraces and adjacent flood plains.

Typical pedon of Detroit silt loam, 2,620 feet south and 2,110 feet west of the NE corner of sec. 34, T. 13 S., R. 1 E.:

Ap—0 to 8 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure; hard, friable; slightly acid; clear smooth boundary.

A12—8 to 13 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure and weak very fine subangular blocky; hard, friable; slightly acid; gradual smooth boundary.

B21t—13 to 24 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium subangular blocky structure; very hard, firm; slightly acid; gradual smooth boundary.

B22t—24 to 38 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; moderate fine and medium subangular blocky structure; very hard, firm; neutral; gradual smooth boundary.

B3—38 to 45 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate medium blocky structure; very hard, firm; threads and concretions of lime are common; strong effervescence; moderately alkaline; clear smooth boundary.

C—45 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; soft, very friable; slight effervescence; moderately alkaline.

The solum is 30 to 50 inches thick. Depth to lime is 25 to 50 inches, and the mollic epipedon is 20 to 45 inches thick.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is slightly acid or neutral. The B2t horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is slightly acid or neutral in the upper part and ranges from neutral to moderately alkaline in the lower part. The C horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is mildly alkaline or moderately alkaline.

Elsmere series

The Elsmere series consists of deep, somewhat poorly drained, rapidly permeable soils on bottom lands along streams flowing out of the sandhills. The Elsmere soils

formed in sandy alluvial-colluvial sediment. Slopes are 0 to 2 percent.

Elsmere soils are commonly adjacent to Ortello, Valentine, and Wells soils in the landscape. The well drained Ortello and Wells soils and the excessively drained Valentine soils are steeper and are above the Elsmere soils.

Typical pedon of Elsmere fine sandy loam, 1,460 feet south and 580 feet east of the NW corner of sec. 8, T. 13 S., R. 2 E.:

Ap—0 to 6 inches; dark gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.

A12—6 to 12 inches; dark gray (10YR 4/1) fine sandy loam with a few coarse sand grains, very dark gray (10YR 3/1) moist; weak fine granular structure; soft, very friable; neutral; gradual smooth boundary.

AC—12 to 18 inches; dark grayish brown (10YR 4/2) loamy fine sand with a few medium and coarse sand grains, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral; gradual smooth boundary.

C1—18 to 44 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; single grain; loose; mildly alkaline; clear smooth boundary.

C2—44 to 60 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; single grain; loose; mildly alkaline.

The mollic epipedon is 10 to 20 inches thick, and the solum is 16 to 36 inches thick. The water table normally is between a depth of 1.5 and 6 feet.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It dominantly is fine sandy loam but the range includes loamy fine sand. Reaction ranges from medium acid to neutral. The AC horizon is intermediate in color, texture, and reaction compared to the A and C horizons. The C horizon, at a depth of less than 40 inches, has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 1 to 3. It is fine sand or loamy fine sand and is slightly acid to mildly alkaline. More clayey and darker layers are below a depth of 40 inches in some pedons. The lower part of some pedons has mottles of high chroma.

Geary series

The Geary series consists of deep, well drained soils on side slopes of creek and river valleys. These soils have moderately slow permeability. They formed in reddish loess. Slopes are 2 to 7 percent.

Geary soils are similar to Wells soils and are commonly adjacent to Crete, Detroit, Irwin, and Muir soils in the landscape. Wells soils have a loam and sandy clay loam B horizon. Crete soils have a silty clay B2t horizon, are less red, and are above the Geary soils. Detroit soils have more clay in the B2t horizon, are less red, and are on adjacent river terraces. Irwin soils have a silty clay B2t and C horizon and are above the Geary soils. Muir soils do not have a B2t horizon, are less red, and are on adjacent terraces.

Typical pedon of Geary silt loam, 2 to 7 percent slopes, 875 feet east and 105 feet north of the SW corner of sec. 25, T. 13 S., R. 2 E.:

A1—0 to 13 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular and subangular blocky structure; hard, friable; slightly acid; gradual smooth boundary.

B21t—13 to 19 inches; brown (7.5YR 4/3) silty clay loam, dark brown (7.5YR 3/3) moist; moderate fine granular and subangular blocky structure; hard, friable; medium acid; clear smooth boundary.

B22t—19 to 43 inches; brown (7.5YR 5/4) silty clay loam with an occasional single coarse sand grain, dark brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; very hard, firm; slightly acid; gradual smooth boundary.

B3—43 to 52 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; weak coarse blocky structure; very hard, firm; neutral; gradual smooth boundary.

Cca—52 to 60 inches; light reddish brown (5YR 6/4) silty clay loam, reddish brown (5YR 4/4) moist; weak coarse blocky structure; hard, firm; slight effervescence; lime concretions and threads are common; moderately alkaline.

The solum is 36 to 60 inches thick, and the mollic epipedon is 10 to 20 inches thick.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2. It is medium acid or slightly acid. The B2t horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 or 4 moist), and chroma of 3 or 4. It is slightly acid or neutral. The C horizon has hue of 7.5YR or 5YR, value of 5 or 6 (4 or 5 moist), and chroma of 4. It ranges from neutral to moderately alkaline. Some pedons contain lime concretions below a depth of 40 inches.

Hedville series

The Hedville series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from noncalcareous sandstone. Slopes are 7 to 15 percent.

Hedville soils are similar to Lancaster and Sogn soils and are commonly adjacent to Lancaster and Wells soils in the landscape. The moderately deep Lancaster soils have a clay loam B2t horizon, are less sloping, and are below the Hedville soils. Sogn soils are shallow over

limestone bedrock. The deep Wells soils have a sandy clay loam B2t horizon, are less sloping, and are below the Hedville soils.

Typical pedon of Hedville loam, from an area of Lancaster-Hedville loams, 3 to 15 percent slopes, 1,140 feet east and 200 feet north of SW corner of sec. 7, T. 11 S., R. 1 E.:

A11—0 to 7 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; medium acid; clear smooth boundary.
A12—7 to 13 inches; dark brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) moist; weak fine granular structure; slightly hard, friable; medium acid; clear smooth boundary.
C1—13 to 16 inches; brown (7.5YR 4/4) fine sandy loam, dark brown (7.5YR 3/4) moist; weak fine granular structure; slightly hard, friable; medium acid; abrupt irregular boundary.
R—16 inches; brown and strong brown sandstone.

Depth to sandstone bedrock is 4 to 20 inches. The solum is 4 to 20 inches thick, and the mollic epipedon is 4 to 18 inches thick. Reaction ranges from medium acid to neutral in all horizons. Coarse fragments do not exceed 35 percent by volume in any horizon.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. The C horizon has hue of 5YR to 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4.

Hobbs series

The Hobbs series consists of deep, well drained, moderately permeable soils on the flood plain of creeks and small drainageways. These soils formed in noncalcareous, silty alluvial-colluvial sediment. Slopes are 0 to 3 percent.

Hobbs soils are similar to Muir soils and are commonly adjacent to Clime, Crete, Irwin, and Muir soils in the landscape. The less frequently flooded Muir soils have a mollic epipedon more than 20 inches thick, have a silty clay loam B2 horizon, and are on terraces. Clime soils are moderately deep and are on side slopes. Crete and Irwin soils have a silty clay B2t horizon and are on side slopes.

Typical pedon of Hobbs silt loam, 2,460 feet west and 860 feet north of the SE corner of sec. 2, T. 12 S., R. 3 E.:

Ap—0 to 8 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; few lenses and coatings of light gray (10YR 7/1) silt; weak fine granular structure; slightly hard, friable; neutral; clear smooth boundary.
C1—8 to 29 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; stratified with thin lenses and coatings of light gray (10YR 7/1) silt; moderate fine granular structure and moderate very fine subangular blocky; slightly hard, friable; neutral; gradual smooth boundary.
C2—29 to 46 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; stratified with thin lenses of light gray (10YR 7/1) silt coatings; moderate fine granular structure; slightly hard, friable; neutral; gradual smooth boundary.
C3—46 to 60 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, friable; moderately alkaline.

The upper 40 inches is free of lime, but some pedons have thin layers of recent surface deposition containing lime.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is dominantly silt loam but the range includes silty clay loam. The A horizon is slightly acid to mildly alkaline. The C horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 1 or 2. It contains thin strata that have higher color value. The C horizon is silt loam or silty clay loam and contains thin strata of more clayey material in the lower part. The C horizon ranges from slightly acid to moderately alkaline.

Irwin series

The Irwin series consists of deep, moderately well drained and well drained soils on broad upland ridgetops and side slopes. These soils have very slow permeability. They formed in clayey sediment weathered from shale. Slopes are 1 to 7 percent.

Irwin soils are similar to Crete soils and are commonly adjacent to Clime, Crete, Geary, and Sogn soils in the landscape. Crete soils have a silty clay loam C horizon and are above the Irwin soils. The moderately deep Clime soils are on steeper slopes below the Irwin soils. Geary soils have a silty clay loam B2t horizon and are below the Irwin soils. The shallow Sogn soils are below the Irwin soils.

Typical pedon of Irwin silty clay loam, 3 to 7 percent slopes, 1,450 feet east and 100 feet south of the NW corner of sec. 4, T. 14 S., R. 3 E.:

A1—0 to 6 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate fine granular structrure; hard, friable; medium acid; clear smooth boundary.
A3—6 to 9 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate fine granular structure and moderate very fine subangular blocky; hard, firm; slightly acid; clear smooth boundary.

B21t—9 to 21 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure; very hard, firm; slightly acid; gradual smooth boundary.

B22t—21 to 30 inches; grayish brown (10YR 5/2) silty clay with patches of dark gray (10YR 4/1) on ped surfaces, dark grayish brown (10YR 4/2) moist; moderate medium blocky structure; very hard, firm; few fine black concretions; mildly alkaline; clear smooth boundary.

B3—30 to 39 inches; brown (10YR 5/3) silty clay, dark grayish brown (10YR 4/2) moist; moderate medium blocky structure; very hard, firm; few fine black concretions; few fine lime concretions; moderately alkaline; clear smooth boundary.

C1—39 to 52 inches; brown (7.5YR 5/4) silty clay with a few patches of grayish brown (10YR 5/2) on ped surfaces, dark brown (7.5YR 4/2) moist; moderate medium blocky structure; very hard, firm; moderately alkaline; clear smooth boundary.

C2—52 to 60 inches; mixed grayish brown (10YR 5/2), pale brown (10YR 6/3), and light brownish gray (2.5Y 6/2) silty clay with a few fine faint brownish yellow (10YR 6/6) mottles; moist colors are dark grayish brown (10YR 4/2), brown (10YR 5/3), and grayish brown (2.5Y 5/2); weak medium blocky structure; very hard, firm; moderately alkaline.

The solum is 32 to 60 inches thick. The mollic epipedon is more than 20 inches thick. Depth to shale or limestone bedrock is more than 40 inches, and depth to a silty clay or clay subhorizon is less than 14 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It ranges from medium acid to neutral. The B horizon has hue of 10YR or 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It ranges from medium acid to neutral in the upper part and neutral to moderately alkaline in the lower part. The C horizon has hue of 2.5Y to 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It is mildly alkaline or moderately alkaline. Some pedons have mottles in the C horizon and lime concretions below a depth of 30 inches.

Lancaster series

The Lancaster series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone and sandy shale. Slopes are 3 to 12 percent.

Lancaster soils are similar to Clime and Hedville soils and are commonly adjacent to Hedville and Wells soils in the landscape. Clime soils do not have a B2t horizon and contain free lime. The shallow Hedville soils do not have a B horizon and are above the Lancaster soils. The deep Wells soils are below the Lancaster soils.

Typical pedon of Lancaster loam, from an area of Lancaster-Hedville loams, 3 to 15 percent slopes, 1,180 feet east and 70 feet south of the NW corner of sec. 18, T. 11 S., R. 1 E.:

A11—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; 2 percent small weathered sandstone fragments; medium acid; clear smooth boundary.

A12—6 to 11 inches; brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) moist; moderate fine granular structure; hard, friable; 2 percent small sandstone fragments; medium acid; clear smooth boundary.

B21t—11 to 17 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; moderate fine and very fine subangular blocky structure; hard, firm; 2 percent sandstone fragments less than 2 inches in diameter; slightly acid; clear smooth boundary.

B22t—17 to 24 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; moderate fine and very fine subangular blocky structure; hard, firm; few fine black stains; slightly acid; clear smooth boundary.

B3—24 to 36 inches; reddish yellow (7.5YR 6/6) sandy clay loam, strong brown (7.5YR 5/6) moist; fine subangular blocky structure; hard, friable; 15 percent shale fragments; few black stains; slightly acid; gradual smooth boundary.

Cr—36 inches; yellow (10YR 7/6) weathered sandy shale, yellowish brown (10YR 5/6) moist; slightly acid.

The solum is 20 to 40 inches thick, and depth to shale or weakly cemented sandstone is 20 to 40 inches. The mollic epipedon is 8 to 20 inches thick. Many pedons have fragments of weathered sandstone throughout the sola.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly loam but ranges to sandy loam and silt loam. Reaction is medium acid or slightly acid. The B2t horizon has hue of 10YR to 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. It is loam, clay loam, or sandy clay loam. Reaction is slightly acid or neutral. The B3 horizon has hue of 7.5YR or 5YR, value of 5 or 6 (4 or 5 moist), and chroma of 4 to 6. It is sandy clay loam, clay loam, fine sandy loam, or loam. The B3 horizon is slightly acid or neutral. In some pedons, mottling or variegation of colors more gray, yellow, or red than the soil matrix is below a depth of 20 inches.

McCook series

The McCook series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in calcareous alluvium. Slopes are 0 to 2 percent.

McCook soils are commonly adjacent to Detroit, Solomon and Sutphen soils in the landscape. Detroit soils have a silty clay loam B2t horizon, do not have free lime in the upper 25 inches, and are on terraces. Solomon and Sutphen soils contain more clay, are less well drained, and are in depressional areas on the flood plain.

Typical pedon of McCook silt loam, 200 feet north and 120 feet west of the SE corner of sec. 28, T. 13 S., R. 2 E.:

A1—0 to 10 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; moderate fine granular structure; slightly hard, friable; violent effervescence; moderately alkaline; abrupt smooth boundary.

AC—10 to 17 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate fine granular structure; hard, friable; violent effervescence; moderately alkaline; clear smooth boundary.

C1—17 to 26 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, friable; very few fine threads of lime in the lower part; violent effervescence; moderately alkaline; clear smooth boundary.

C2—26 to 54 inches; light gray (10YR 7/2) very fine sandy loam, light brownish gray (10YR 6/2) moist; massive; soft, very friable; violent effervescence; few fine threads of lime; moderately alkaline; clear smooth boundary.

C3—54 to 60 inches; light gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; violent effervescence; moderately alkaline.

The solum is 17 to 33 inches thick, and the mollic epipedon is 10 to 20 inches thick. Typically, free lime is at the surface but ranges to 10 inches deep in some pedons. All horizons are mildly alkaline or moderately alkaline.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam but the range includes very fine sandy loam. The AC and C horizons have hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma near 2. These horizons are silt loam or very fine sandy loam. Faint mottles are below a depth of 30 inches in some places.

Muir series

The Muir series consists of deep, well drained, moderately permeable soils on low terraces. These soils formed in noncalcareous silty alluvium. Slopes are 0 to 2 percent.

Muir soils are similar to Detroit and Hobbs soils, and are commonly adjacent to Crete, Geary, Hobbs, and Irwin soils in the landscape. Detroit soils have a clayey B2t horizon, and are on river terraces. Hobbs soils do not have a B horizon and are on flood plains. Crete and Irwin soils have a silty clay B2t horizon and are on side slopes. Geary soils have a redder silty clay loam B2t horizon and are on side slopes.

Typical pedon of Muir silt loam, 2,000 feet west and 1,680 feet south of the NE corner of sec. 13, T. 14 S., R. 4 E.:

Ap—0 to 8 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure; hard, friable; neutral; clear smooth boundary.

A12—8 to 15 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; hard, friable; medium acid; clear smooth boundary.

B1—15 to 22 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure and moderate very fine subangular blocky; hard, friable; slightly acid; gradual smooth boundary.

B21—22 to 29 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine subangular blocky structure; hard, friable; slightly acid; gradual smooth boundary.

B22—29 to 38 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine subangular blocky structure; hard, friable; neutral; gradual smooth boundary.

B3—38 to 48 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate fine and very fine subangular blocky structure; hard, friable; neutral; clear smooth boundary.

Cca—48 to 60 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak fine and very fine subangular blocky structure; hard, friable; violent effervescence; fine threads and soft accumulations of lime; mildly alkaline.

The solum is 24 to 48 inches thick. The mollic epipedon is 20 to 48 inches thick.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam but ranges to loam. Reaction ranges from medium acid to neutral. The B horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is silty clay loam, silt loam, and loam. Reaction ranges from slightly acid to mildly alkaline. The C horizon has hue of 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 2 or 3. It is silty clay loam, silt loam, and loam. Reaction ranges from slightly acid to mildly alkaline. Some pedons contain mottles of higher chroma below a depth of 40 inches.

Ortello series

The Ortello series consists of deep, well drained soils on uplands. These soils have moderately rapid permeability. They formed in sandy eolian and alluvial deposits. Slopes are 1 to 6 percent.

Ortello soils are similar to Valentine soils and are commonly adjacent to Carwile, Elsmere, Valentine and Wells soils in the landscape. Valentine soils have loamy fine sand A and C horizons, do not have a B horizon, and are in similar positions in the landscape. The somewhat poorly drained Carwile soils have a clay loam B2t horizon and are in low areas and depressions. The somewhat poorly drained Elsmere soils have a seasonal high water table and are on bottom lands. Wells soils have a redder and finer textured B2t horizon and are on the upper parts of slopes.

Typical pedon of Ortello fine sandy loam, from an area of Ortello-Wells fine sandy loams, undulating, 2,465 feet west and 65 feet north of the SE corner of sec. 7, T. 13 S., R. 2 E.:

Ap—0 to 8 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and very fine granular structure; soft, very friable; slightly acid; abrupt smooth boundary.

A12—8 to 16 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.

B2—16 to 35 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable; slightly acid; gradual smooth boundary.

C1—35 to 46 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; massive; soft, very friable; neutral; gradual smooth boundary.

C2—46 to 60 inches; brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) moist; single grain; loose; mildly alkaline.

The solum is 16 to 36 inches thick. These soils do not have free lime above a depth of 60 inches. Reaction is slightly acid in the A horizon and neutral or mildly alkaline in the C horizon.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2. It is dominantly fine sandy loam, but the range includes loamy fine sand. Reaction is slightly acid or neutral. The B horizon has hue of 10YR, value of 4 or 5 (4 moist), and chroma of 3 or 4. It is fine sandy loam. Reaction is slightly acid or neutral. The C horizon is fine sandy loam or loamy fine sand.

Sogn series

The Sogn series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone. Slopes are 5 to 8 percent.

Sogn soils are similar to Hedville soils, and are commonly adjacent to Clime, Hobbs, and Irwin soils in the landscape. Hedville soils are shallow over sandstone bedrock. The moderately deep Clime soils have a silty clay loam B2 horizon and are above and below Sogn soils in the same landscape. The deep Hobbs soils are on bottom lands. The deep Irwin soils have a silty clay B2t horizon and are above the Sogn soils.

Typical pedon of Sogn silt loam, from an area of Clime-Sogn complex, 5 to 20 percent slopes, 880 feet west and 60 feet north of the SE corner of sec. 7, T. 13 S., R. 4 E.:

A11—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate fine and medium granular structure; hard, friable; mildly alkaline; clear smooth boundary.

A12—8 to 14 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; moderate fine and medium granular structure; hard, friable; strong effervescence; 15 percent limestone fragments less than 2 inches in size; moderately alkaline; abrupt smooth boundary.

R—14 inches; limestone with fractures generally more than 12 inches apart.

The thickness of solum and depth to hard limestone are 4 to 20 inches. The soil ranges from neutral to moderately alkaline.

The A horizon has hue of 10YR, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. The texture is dominantly silt loam but the range includes silty clay loam. The A horizon of some pedons contains limestone fragments. Coarse fragments make up less than 15 percent by volume.

Solomon series

The Solomon series consists of deep, poorly drained soils in depressions on flood plains. These soils have very slow permeability. They formed in calcareous clayey alluvium. Slopes are 0 to 1 percent.

Solomon soils are similar to Sutphen soils and are commonly adjacent to Detroit, McCook, and Sutphen soils in the landscape. Sutphen soils are not as poorly drained, do not have a B horizon, and are on higher areas of the flood plain and adjacent terrace. The well drained Detroit soils contain less clay and are on the adjacent terrace. McCook soils are well drained, contain less clay, and are on the highest part of the flood plain.

Typical pedon of Solomon silty clay, 1,480 feet east and 1,180 feet south of the NW corner of sec. 35, T. 13 S., R. 1 E.:

Ap—0 to 10 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; weak fine granular structure; very hard, firm; strong effervescence; moderately alkaline; clear smooth boundary.

B2g—10 to 23 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium blocky structure; very hard, very firm; strong effervescence; moderately alkaline; gradual smooth boundary.

B3g—23 to 45 inches; mixed gray (10YR 5/1) and dark gray (10YR 4/1) silty clay, dark gray (10YR 4/1) and very dark gray (10YR 3/1) moist; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate coarse blocky structure; very hard, very firm; few lime concretions; violent effervescence; moderately alkaline; gradual smooth boundary.

Cg—45 to 60 inches; gray (10YR 5/1) silty clay, dark gray (10YR 4/1) moist; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium blocky structure; very hard, firm; few fine black concretions; small lime concretions are common; violent effervescence; moderately alkaline.

The solum is 40 to 60 inches thick. Depth to free lime is less than 10 inches. The mollic epipedon is more than 15 inches thick.

The A horizon has hue of 10YR, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is mildly alkaline or moderately alkaline. The Bg horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. In some pedons the Bg horizon has faint or distinct mottles in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 1 or 2. The C horizon generally is mottled.

Sutphen series

The Sutphen series consists of deep, moderately well drained and somewhat poorly drained soils on low terraces along the river. These soils have very slow permeability. They formed in clayey alluvium. Slopes are 0 to 1 percent.

Sutphen soils are similar to Solomon soils and are commonly adjacent to Detroit, McCook, and Solomon soils in the landscape. The poorly drained Solomon soils are in depressions and old meander scars on the flood plain. The well drained Detroit soils have a silty clay loam B2t horizon and are on the highest part of the terrace. The well drained McCook soils contain less clay and are on the flood plain.

Typical pedon of Sutphen silty clay, 1,980 feet south and 115 feet west of the NE corner of sec. 14, T. 13 S., R. 2 E.:

Ap—0 to 7 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak fine granular structure and weak fine blocky; very hard, firm; neutral; abrupt smooth boundary.

A12—7 to 24 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; moderate medium blocky structure; very hard, very firm; neutral; clear smooth boundary.

AC—24 to 32 inches; dark gray (10YR 4/1) silty clay, very dark grayish brown (10YR 3/2) moist; some vertical streaks of dark gray (10YR 4/1), black (10YR 2/1) moist; weak medium blocky structure; very hard, very firm; few fine black concretions; neutral; clear smooth boundary.

C1—32 to 48 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; few narrow vertical streaks of dark gray (10YR 4/1), black (10YR 2/1) moist; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium blocky structure; very hard, firm; few fine black concretions; common fine lime concretions; moderately alkaline; gradual smooth boundary.

C2—48 to 60 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; few fine faint dark yellowish brown (10YR 4/4) mottles; massive; very hard, firm; few soft accumulations of lime; moderately alkaline.

The solum is 24 to 50 inches thick. The mollic epipedon is 26 to 50 inches thick. Depth to free lime is 24 to 36 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is silty clay loam or silty clay and ranges from slightly acid to moderately alkaline. The AC horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 1 or 2. It ranges from neutral to moderately alkaline. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. The C horizon is silty clay in the upper part and silty clay or silty clay loam in the lower part.

Valentine series

The Valentine series consists of deep, excessively drained, rapidly permeable soils on uplands. These soils formed in eolian sands. Slopes are 1 to 15 percent.

Valentine soils are similar to Ortello soils and are commonly adjacent to Carwile, Elsmere, Ortello, and Wells soils in the landscape. Ortello soils have a mollic epipedon, have a fine sandy loam B horizon, and are on similar undulating areas. The somewhat poorly drained Carwile soils have a clay loam B2t horizon and are in low areas and depressions. The somewhat poorly drained Elsmere soils have a seasonal high water table and are on bottom lands. Wells soils have a redder sandy clay loam B2t horizon and are on upper parts of side slopes in undulating areas.

Typical pedon of Valentine loamy fine sand, rolling, 2,340 feet south and 200 feet west of the NE corner of sec. 16, T. 13 S., R. 1 E.:

A1—0 to 7 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral; clear smooth boundary.
AC—7 to 15 inches; brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable; slightly acid; gradual smooth boundary.
C—15 to 60 inches; light yellowish brown (10YR 6/4) loamy fine sand, yellowish brown (10YR 5/4) moist; single grain; loose; slightly acid.

The solum is 8 to 17 inches thick. Reaction is slightly acid or neutral in all horizons.

The A horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2. The AC horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. The C horizon has hue of 10YR, value of 6 or 7 (5 or 6 moist), and chroma of 3 or 4. The C horizon is loamy fine sand or fine sand.

Wells series

The Wells series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in old alluvium and material weathered from noncalcareous sandstone and sandy shale. Slopes are 3 to 7 percent.

Wells soils are similar to Geary soils and are commonly adjacent to Hedville, Lancaster, and Ortello soils in the landscape. Geary soils have a silty clay loam B2t horizon. The shallow Hedville soils and moderately deep Lancaster soils are steeper and are above the Wells soils. Ortello soils contain more sand and do not have a B2t horizon.

Typical pedon of Wells loam, 3 to 7 percent slopes, 745 feet east and 205 feet north of the SW corner of sec. 3, T. 11 S., R. 1 E.:

A1—0 to 8 inches; dark gray (10YR 4/1) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; slightly acid; clear smooth boundary.
A3—8 to 12 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, friable; medium acid; clear smooth boundary.
B1—12 to 19 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, friable; medium acid; clear smooth boundary.
B2t—19 to 33 inches; strong brown (7.5YR 5/6) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate fine granular structure; hard, friable; slightly acid; clear smooth boundary.
B3—33 to 44 inches; light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 5/4) moist; common fine distinct yellowish red (5YR 4/6) mottles; moderate fine granular structure; hard, friable; slightly acid; gradual smooth boundary.
C—44 to 60 inches; strong brown (7.5YR 5/6) sandy loam, brown (7.5YR 5/4) moist; many medium distinct yellowish red (5YR 4/6) and very pale brown (10YR 7/3) mottles; massive; hard, friable; few black concretions; slightly acid.

The solum is 35 to 50 inches thick, and the mollic epipedon is 12 to 20 inches thick. Depth to bedrock is more than 40 inches.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is commonly loam, but the range includes fine sandy loam. Reaction is medium acid or slightly acid. The B1 horizon has the same range in color and reaction as the A horizon. The B2t horizon has hue of 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 to 6. It is clay loam or sandy clay loam. Reaction is slightly acid or neutral. The C horizon has hue of 7.5YR or 5YR, value of 5 to 7 (5 or 6 moist), and chroma of 4 to 6. It is clay loam, sandy clay loam, loam, or sandy loam. Reaction is slightly acid or neutral.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (*5*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 18, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis

and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustoll (*Ust*, meaning intermittent dryness, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplustolls (*Hapl*, meaning simple horizons, plus *ustoll*, the suborder of Mollisols that have an ustic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceeding the name of the great group. The adjective *Pachic* identifies the subgroup that has a thicker surface layer than is typical for the great group. An example is Pachic Haplustolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-silty, mixed, mesic, Pachic Haplustolls.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Formation of the soils

Soil is formed through processes that act on parent material. Characteristics of the soil are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief or lay of the land, and (5) the length of time the factors of soil formation have acted on the parent material. All five factors come into play in the formation of every soil.

Parent material

Parent material is the weathered rock or partly weathered material from which soils form. Weathering of rock takes place through the processes of freezing and thawing, abrasion, and wind erosion; water and glaciers acting on the soil; and chemical processes. Parent material affects the texture, structure, color, natural fertility, and many other properties of the soil. Soils differ partly because of differences in parent material. The texture of the parent material, which determines the rate of the downward movement of water, greatly influences soil formation. The composition of the geologic material largely determines the mineralogical composition of the soil and, hence, its natural fertility. This material is the chief source of all plant nutrient elements except nitrogen.

Alluvium is water-laid material in stream valleys. The alluvium in the valley of the Smoky Hill River consists of sediment derived from the Rocky Mountain region mixed with local material. Sediment along the small drainageways and in the creek valleys is of local origin. Alluvial soils are generally young when compared to the age of many other soils. Detroit, Elsmere, Hobbs, McCook, Muir, Solomon, and Sutphen soils formed in alluvial material.

Eolian sand consists of sandy material transported by wind. The most likely source of the eolian sand in Dickinson County was the alluvial sediment deposited by the Smoky Hill River. This sandy deposition probably occurred during the glacial episodes of late Pleistocene time, when alluviation of stream channels was taking place rapidly. Ortello and Valentine soils formed in this sandy material.

Loess consists of silty and clayey wind-borne material that is sometimes carried hundreds of miles from its source. Most of the loess in the survey area was deposited when glaciers covering areas north of Kansas receded. Loess of two different ages exists in Dickinson County. Peorian loess, the youngest, is the parent material of Crete soils and was deposited during Wisconsinan time. Loveland loess is the parent material of the Geary soils and was deposited during Illinoian time.

Most of the consolidated bedrock that outcrops in Dickinson County is of the Cretaceous and Permian Systems. Soils that formed in material weathered from Cretaceous rocks are Hedville, Lancaster, and Wells soils. Soils that formed in material weathered from Permian rocks are Clime, Irwin, and Sogn soils.

Climate

Climate influences both the physical and chemical processes of weathering and the biological forces at

work in the soil. If the supply of moisture is adequate, these processes become more active as the soil temperature increases. They are limited by either inadequate or excess moisture.

The soils of Dickinson County formed under a subhumid climate. Summers are hot, and winters are moderately cold. Climate has significantly affected development of the soils.

Temperature affects the decomposition of organic matter, the growth of organisms, and the rate of chemical reaction in soils. The moderate amount of precipitation in Dickinson County has influenced the growth of tall prairie grasses. The downward movement of water is one of the main factors in the transformation of the parent material into a soil that has distinct horizons. As water moves downward through the soil, calcium carbonate and salts are leached from the soil and carried downward to form a horizon of enrichment or are carried out of the profile. The translocation of clay is partly caused by the downward movement of water.

The amount of water that percolates downward through the soil depends not only on rainfall, temperature, humidity, and soil material but also on relief, or the lay of the land. For example, Hobbs soils, on the flood plains along local streams, receive extra water and deposition from runoff and flooding.

For more information about precipitation and temperature in Dickinson County, see "Climate" in the section "General nature of the county."

Plant and animal life

Two important functions of plants and animals in the soil-forming process are furnishing organic matter to the soil and mixing the soil by transporting soil and plant nutrients from one layer to another. Trunks, stems, leaves, and roots of plants are the chief sources of organic matter. This organic matter creates a more favorable environment for biological activity within the soil by providing food for micro-organisms. Animal life, consisting of bacteria, fungi, and other organisms, aids in the weathering of rock and in the decomposing of organic matter. These organisms influence the chemical, physical, and biological processes that strongly affect soil formation. Earthworms feed on organic matter and make channels, and in this way, they throughly mix the soil in which they live. Burrowing animals affect soil formation mainly by mixing soil horizons. They also add fresh material to the surface horizons.

Most soils in Dickinson County formed under tall prairie grasses. The remains of these grasses have been decomposed and have accumulated over a long period of time. As a result, a great deal of organic matter has been incorporated in the upper part of the soil, which is characteristically dark colored.

Man has a great effect on the formation of soil. Management that controls erosion is changing the relief, or lay of the land, and the surface and subsurface drainage pattern. Erosion and earthmoving in some locations have removed the original upper part of the soil, the part containing the highest amount of organic matter and nutrients, and have exposed the subsoil and substratum which, in many areas, are deficient in plant nutrients. In this way, man has offset the normal processes of soil formation.

Relief

Relief, or lay of the land, influences soil formation through its affect on the amount of water retained, erosion, the direction that material in suspension or solution is moved, and plant cover. The amount of water that moves into the soil depends partly on topography. In the steeper areas, the continued removal of soil from the surface and the loss of water through runoff slow down the processes of soil formation. The soils in nearly level and depressed areas receive the same amount of precipitation annually as the soils on steeper slopes, but they also receive the runoff and deposition from the sloping areas. Consequently, these nearly level or depressed soils generally show stronger evidence of soil development than those in the sloping areas and are darkened to a greater depth. For example, Hedville soils, which are on the steeper, upper side slopes, are shallow; and Wells soils, which are on the less steep, lower side slopes, are deep.

Time

Time is required for soil formation. The length of time required depends mainly on the other factors of soil formation. Soils form slowly in a dry climate and under sparse vegetation and form much more rapidly in a moist climate and under dense vegetation. Water moves through the soil profile and, gradually, soluble matter and fine particles are leached from the surface layer and deposited in the subsoil. The amount of leaching depends on how much time has elapsed and the amount of water that penetrates the soil. The continual loss of soil from the surface through erosion removes the material affected by soil-forming processes and exposes the material that is little altered by these processes. For example, Crete soils in the nearly level and gently sloping areas have been exposed to soil-forming processes for thousands of years; consequently, they are deep and show strong evidence of soil formation. The younger Hedville soils in the steeper areas are shallow and show less evidence of soil formation.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured (light textured) soil. Sand or loamy sand.

Complex, soil. A map unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is

deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Pan. A compact, dense layer in a soil. A pan impedes the movement of water and the growth of roots. The word "pan" is commonly combined with other words that more explicitly indicate the nature of the layer; for example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair,* and *poor*. The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slick spot. Locally, a small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or " very fine."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil

in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.
Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.
Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.
Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

ILLUSTRATIONS

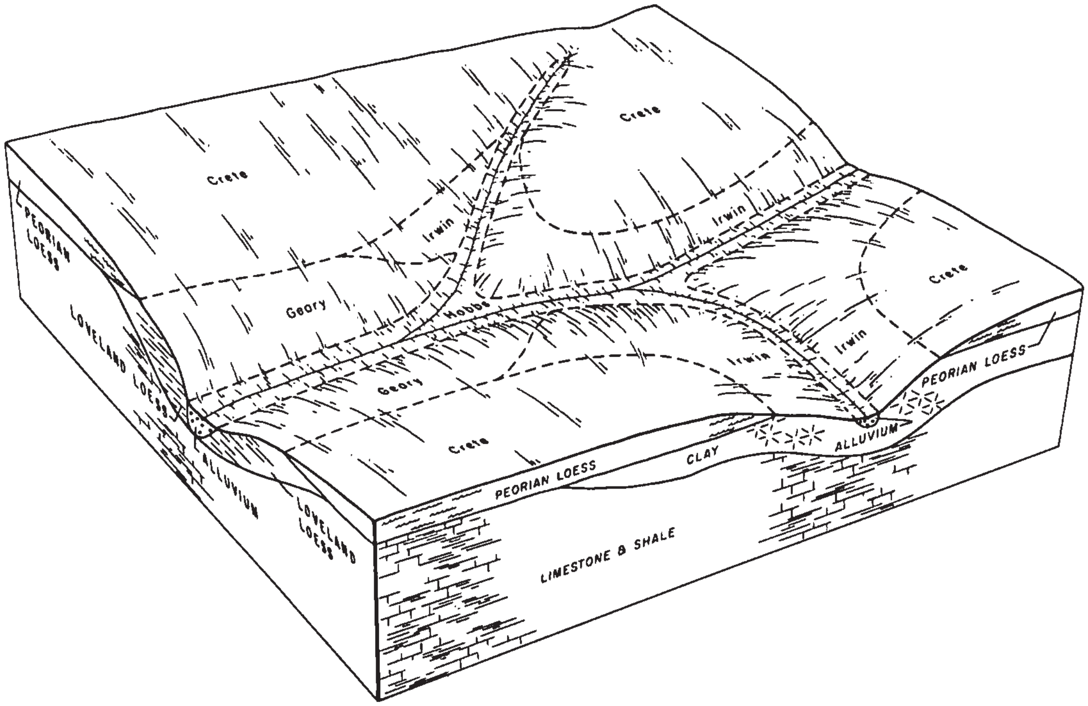

Figure 1.—Major soils of the Crete-Irwin-Geary map unit and their normal position on the landscape.

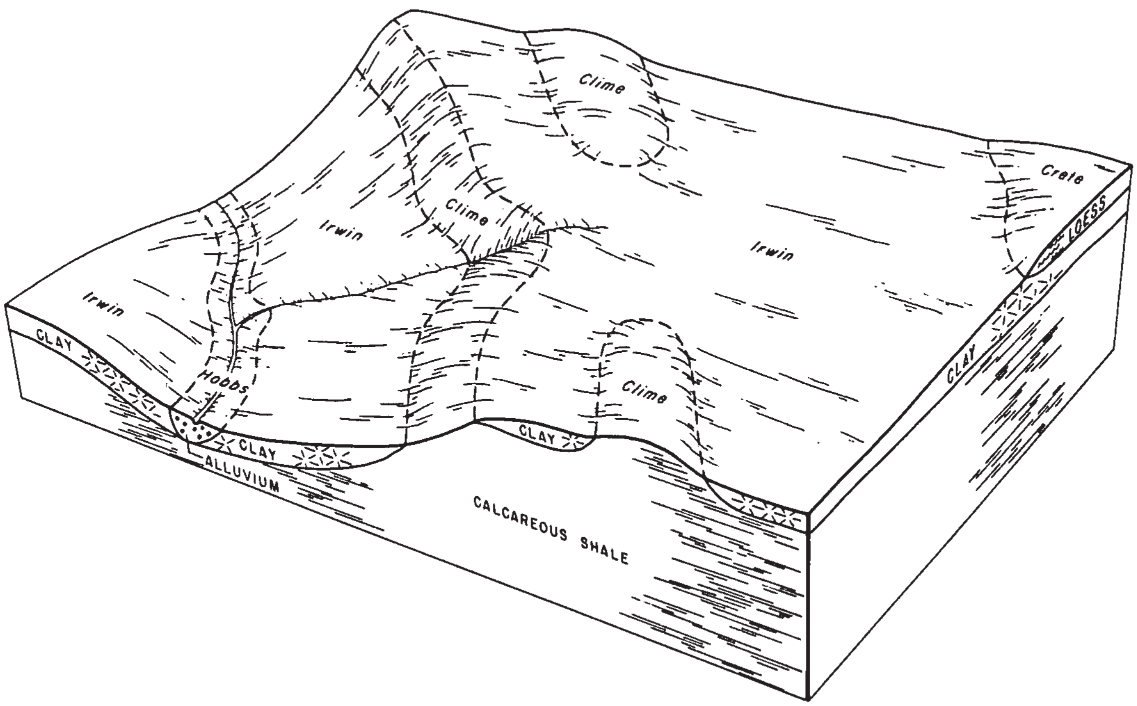

Figure 2.—Major soils of the Irwin-Clime map unit and their normal position on the landscape.

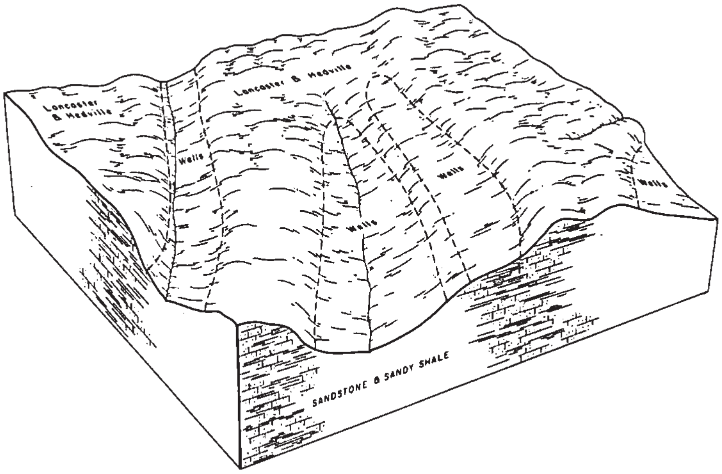

Figure 3.—Major soils of the Wells-Lancaster-Hedville map unit and their normal position on the landscape.

Figure 4.—Typical landscape of Clime silty clay loam, 2 to 6 percent slopes. Shale and limestone fragments are common on the surface in many places.

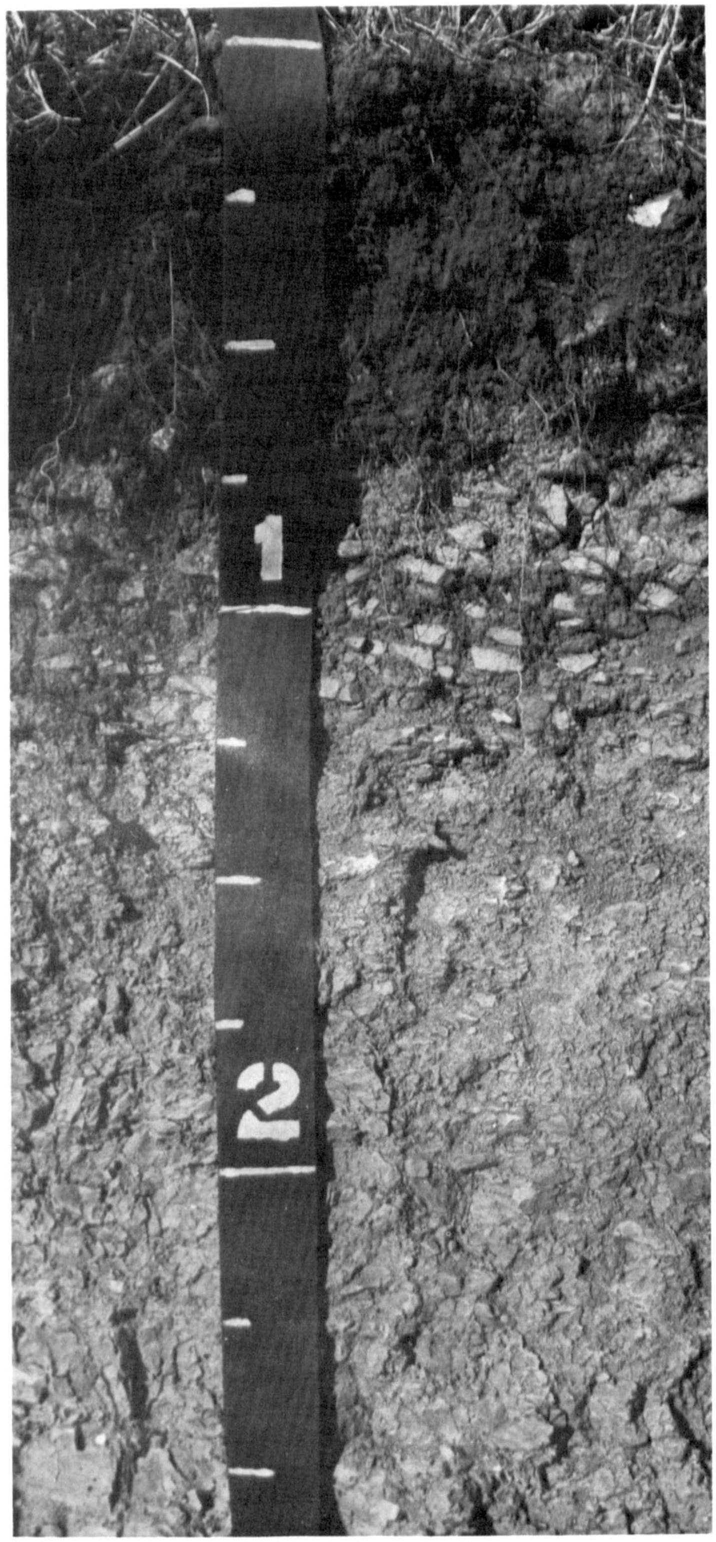

Figure 5.—Profile of Clime silty clay loam that has channery limestone fragments in the lower part of the surface layer.

Figure 6.—Typical landscape of Clime-Sogn complex, 5 to 20 percent slopes.

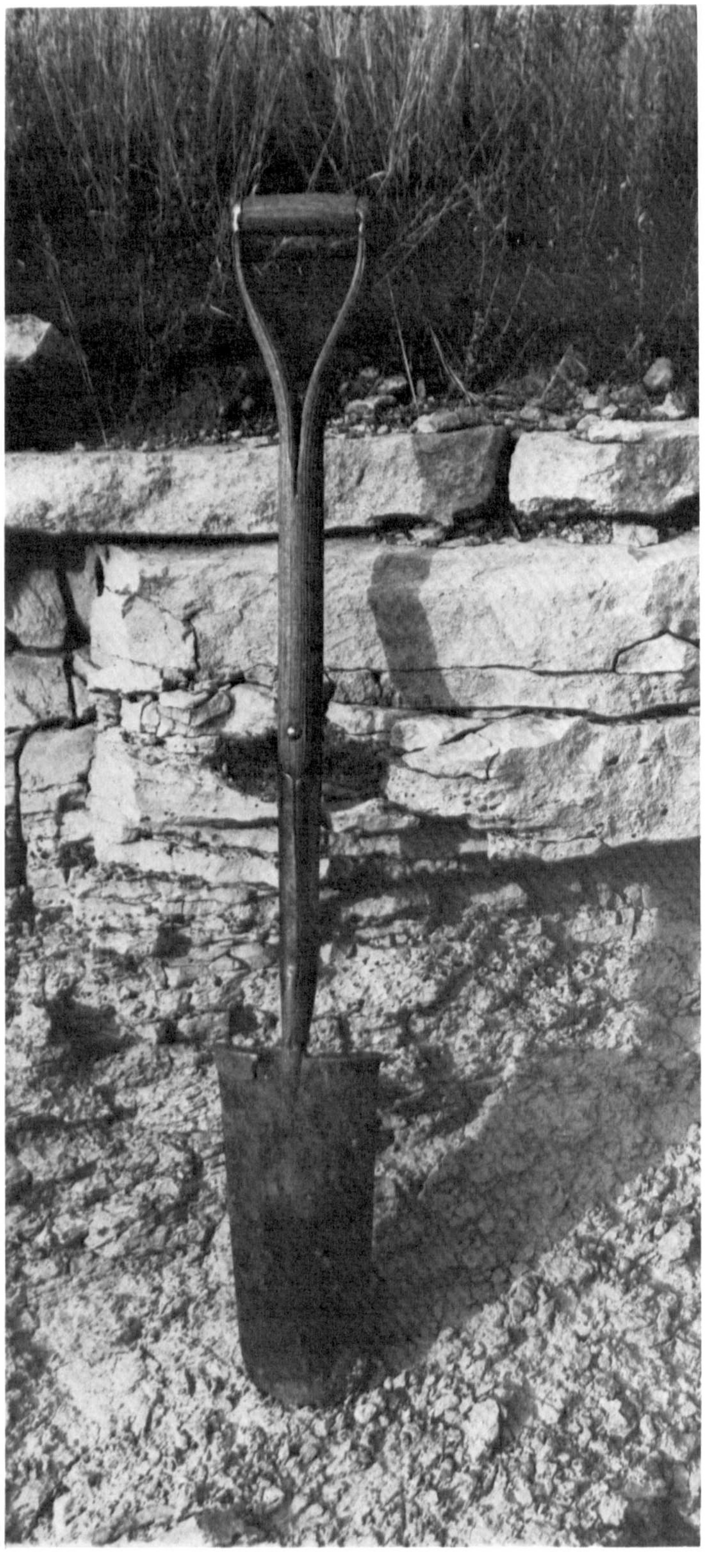

Figure 7.—Profile of Sogn silt loam. It is about 5 inches thick over limestone bedrock.

Figure 8.—Soybeans on Crete silty clay loam, 1 to 3 percent slope.

Figure 9.—Grain sorghum on Detroit silt loam.

Figure 10.—Irrigating alfalfa on Detroit silt loam.

Figure 11.—Flood-damaged soybeans on Hobbs silt loam.

Figure 12.—Typical landscape of Hobbs silt loam, channeled.

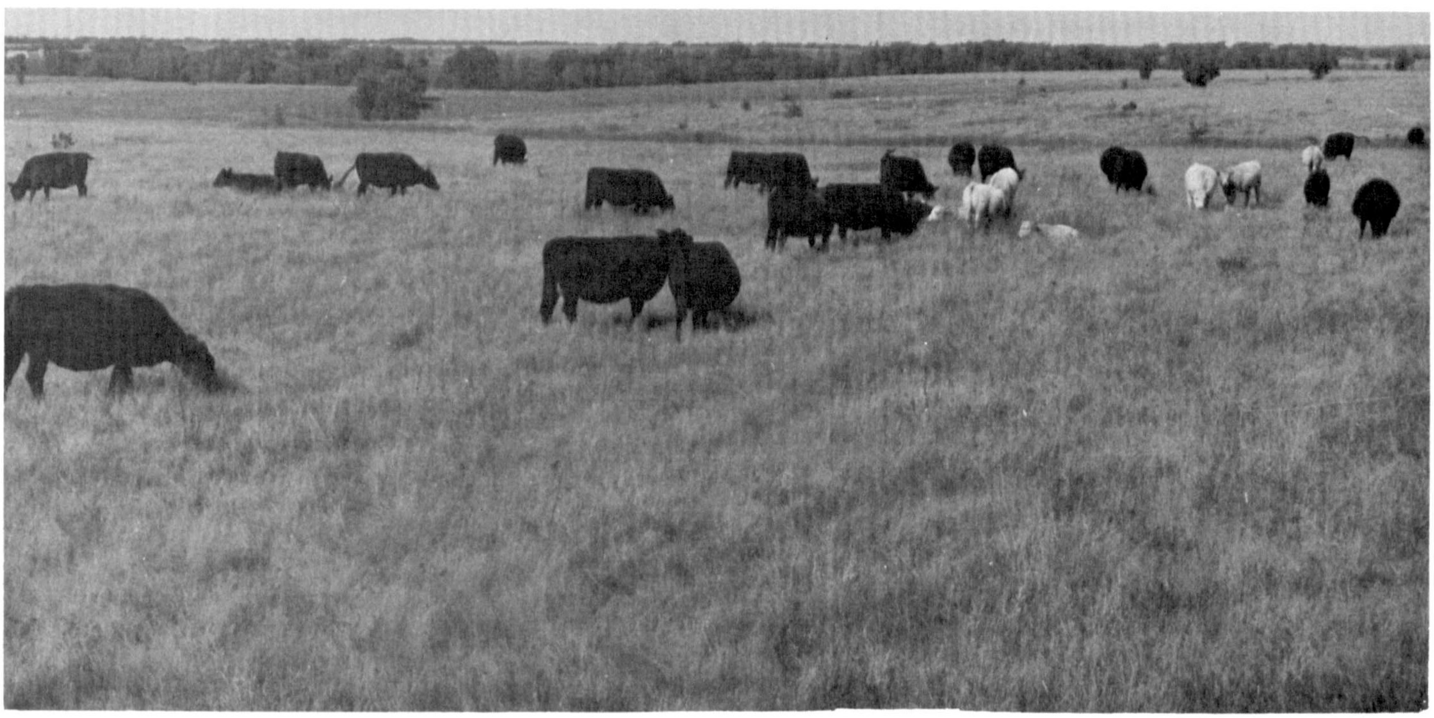

Figure 13.—Native range on Irwin silty clay loam, 1 to 3 percent slopes.

Figure 14.—Baled native hay on typical landscape of Irwin silty clay loam, 1 to 3 percent slopes and Irwin silty clay loam, 3 to 7 percent slopes.

Figure 15.—Typical area of Lancaster-Hedville loams, 3 to 15 percent slopes.

Figure 16.—Irrigated corn on McCook silt loam being harvested for silage.

Figure 17.—Wheat on typical landscape of Ortello-Wells fine sandy loams, undulating.

Figure 18.—Grain sorghum is difficult to establish on Solomon silty clay.

Figure 19.—Typical area of Valentine loamy fine sand, rolling.

Figure 20.—Wheat in a typical area of Valentine loamy fine sand, undulating.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

[Recorded in the period 1941-70 at Herington, Kansas]

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January	39.6	18.6	29.1	65	-10	0.86	0.18	1.32	2	4.5
February	45.3	23.0	34.2	69	-4	1.07	0.40	1.71	3	5.0
March	53.9	30.1	42.0	83	0	1.88	0.84	2.81	4	5.5
April	67.3	43.1	55.2	87	21	3.07	1.37	4.57	5	1.1
May	76.2	53.1	64.7	93	33	4.19	2.38	5.24	7	0.0
June	85.0	62.6	73.8	100	43	5.82	3.28	8.41	8	0.0
July	90.5	66.9	78.7	104	52	4.09	1.82	6.93	6	0.0
August	90.2	66.1	78.2	103	48	3.18	1.36	5.61	5	0.0
September	81.4	56.9	69.1	98	37	4.22	1.15	6.86	6	0.0
October	70.8	46.5	58.7	91	26	3.06	1.31	5.05	4	0.3
November	54.6	32.4	43.5	75	8	1.06	0.19	1.85	2	1.3
December	42.7	22.6	32.7	66	-5	1.19	0.43	1.92	3	5.1
Year	66.5	43.5	55.0	104	-10	33.69	24.49	40.93	55	22.8

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1941-70 at Dickinson County, Kansas]

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 12	April 25	May 6
2 years in 10 later than--	April 7	April 20	May 1
5 years in 10 later than--	March 29	April 10	April 21
First freezing temperature in fall:			
1 year in 10 earlier than--	October 22	October 15	October 6
2 years in 10 earlier than--	October 26	October 20	October 10
5 years in 10 earlier than--	November 5	October 29	October 20

TABLE 3.--GROWING SEASON LENGTH

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10----	198	180	160
8 years in 10----	206	187	168
5 years in 10----	221	202	182
2 years in 10----	236	215	197
1 year in 10	243	223	205

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ca	Carwile loam	920	0.2
Cb	Clime silty clay loam, 2 to 6 percent slopes	16,200	3.0
Cc	Clime silty clay loam, 6 to 15 percent slopes	13,900	2.5
Cd	Clime-Sogn complex, 5 to 20 percent slopes	24,700	4.5
Ce	Crete silty clay loam, 0 to 1 percent slopes	15,100	2.7
Cf	Crete silty clay loam, 1 to 3 percent slopes	55,700	10.2
Cg	Crete silty clay loam, 3 to 7 percent slopes	18,400	3.4
Da	Detroit silt loam	9,760	1.8
Ea	Elsmere fine sandy loam	880	0.2
Fa	Fluvaquents, clayey	668	0.1
Ga	Geary silt loam, 2 to 7 percent slopes	26,800	4.9
Ha	Hobbs silt loam	31,100	5.7
Hb	Hobbs silt loam, channeled	14,100	2.6
Ia	Irwin silty clay loam, 1 to 3 percent slopes	129,400	23.6
Ib	Irwin silty clay loam, 3 to 7 percent slopes	114,100	20.8
La	Lancaster-Hedville loams, 3 to 15 percent slopes	6,030	1.1
Ma	McCook silt loam	9,370	1.7
Mb	Muir silt loam	24,600	4.5
Oa	Ortello-Wells fine sandy loams, undulating	7,690	1.4
Qa	Quarries	600	0.1
Sb	Solomon silty clay	2,050	0.4
Sc	Sutphen silty clay loam	9,250	1.7
Sd	Sutphen silty clay	4,240	0.8
Va	Valentine loamy fine sand, rolling	2,360	0.4
Vb	Valentine loamy fine sand, undulating	4,250	0.8
Wa	Wells loam, 3 to 7 percent slopes	4,840	0.9
	Water	192	*
	Total	547,200	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Grain sorghum	Winter wheat	Alfalfa hay	Smooth bromegrass	Soybeans
	Bu	Bu	Ton	AUM*	Bu
Ca------------------------ Carwile	55	28	3.0	5.0	22
Cb------------------------ Clime	50	30	2.0	4.0	16
Cc------------------------ Clime	---	---	---	4.0	---
Cd. Clime-Sogn					
Ce------------------------ Crete	70	40	3.5	5.0	26
Cf------------------------ Crete	65	38	3.0	4.5	24
Cg------------------------ Crete	60	36	2.5	4.0	20
Da------------------------ Detroit	70	40	4.0	5.5	30
Ea------------------------ Elsmere	50	34	2.5	4.0	18
Fa**. Fluvaquents					
Ga------------------------ Geary	65	36	3.0	5.0	22
Ha------------------------ Hobbs	70	36	4.0	6.0	32
Hb. Hobbs					
Ia------------------------ Irwin	65	38	3.0	5.0	22
Ib------------------------ Irwin	60	36	2.5	4.5	18
La. Lancaster-Hedville					
Ma------------------------ McCook	75	42	4.0	6.0	32
Mb------------------------ Muir	75	42	4.0	6.0	34
Oa------------------------ Ortello-Wells	60	34	3.0	5.0	22
Qa**. Quarries					
Sb------------------------ Solomon	60	34	3.0	5.5	24

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Grain sorghum	Winter wheat	Alfalfa hay	Smooth bromegrass	Soybeans
	Bu	Bu	Ton	AUM*	Bu
Sc------------------------- Sutphen	70	36	3.5	5.5	28
Sd------------------------- Sutphen	65	34	3.0	5.0	26
Va. Valentine					
Vb------------------------- Valentine	55	30	1.5	3.5	---
Wa------------------------- Wells	65	36	3.5	5.5	24

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation are listed]

Soil name and map symbol	Range site name	Total production		Characteristic vegetation	Compo-sition
		Kind of year	Dry weight		
			Lb/acre		Pct
Cb, Cc---------- Clime	Limy Upland----------	Favorable	5,000	Little bluestem----------	30
		Normal	3,500	Big bluestem----------	20
		Unfavorable	2,500	Sideoats grama----------	15
				Indiangrass----------	5
				Switchgrass----------	5
				Blue grama----------	5
Cd*:					
Clime----------	Limy Upland----------	Favorable	5,000	Little bluestem----------	30
		Normal	3,500	Big bluestem----------	20
		Unfavorable	2,500	Sideoats grama----------	15
				Indiangrass----------	5
				Switchgrass----------	5
				Blue grama----------	5
Sogn----------	Shallow Limy----------	Favorable	3,500	Big bluestem----------	20
		Normal	2,500	Little bluestem----------	20
		Unfavorable	1,500	Sideoats grama----------	20
				Indiangrass----------	5
				Switchgrass----------	5
				Tall dropseed----------	5
Ce, Cf, Cg---------- Crete	Clay Upland----------	Favorable	5,000	Big bluestem----------	23
		Normal	4,000	Little bluestem----------	17
		Unfavorable	2,000	Switchgrass----------	8
				Sideoats grama----------	8
				Indiangrass----------	6
				Western wheatgrass----------	5
				Tall dropseed----------	5
Da---------- Detroit	Loamy Terrace----------	Favorable	6,000	Big bluestem----------	30
		Normal	5,000	Western wheatgrass----------	5
		Unfavorable	4,000	Little bluestem----------	10
				Switchgrass----------	10
				Sideoats grama----------	5
				Indiangrass----------	10
Ea---------- Elsmere	Subirrigated----------	Favorable	8,000	Big bluestem----------	30
		Normal	7,000	Indiangrass----------	15
		Unfavorable	6,000	Prairie cordgrass----------	15
				Switchgrass----------	10
				Little bluestem----------	5
				Sedge----------	10
Ga---------- Geary	Loamy Upland----------	Favorable	6,000	Big bluestem----------	25
		Normal	4,000	Little bluestem----------	20
		Unfavorable	3,000	Switchgrass----------	10
				Indiangrass----------	10
				Tall dropseed----------	5
				Stiff goldenrod----------	5
				Sideoats grama----------	5
Ha, Hb---------- Hobbs	Loamy Lowland----------	Favorable	7,000	Big bluestem----------	35
		Normal	5,000	Western wheatgrass----------	15
		Unfavorable	3,500	Switchgrass----------	10
				Little bluestem----------	5
				Indiangrass----------	10
				Sideoats grama----------	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ia, Ib: Irwin	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	2,000	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5
La*:					
Lancaster	Loamy Upland	Favorable	5,000	Big bluestem	25
		Normal	3,500	Little bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5
				Sedge	5
Hedville	Shallow Sandstone	Favorable	4,000	Little bluestem	35
		Normal	3,000	Big bluestem	20
		Unfavorable	2,000	Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
				Tall dropseed	5
Ma: McCook	Loamy Terrace	Favorable	5,000	Big bluestem	30
		Normal	4,000	Little bluestem	10
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Western wheatgrass	5
				Canada wildrye	5
				Sedge	5
Mb: Muir	Loamy Terrace	Favorable	6,500	Big bluestem	30
		Normal	5,000	Indiangrass	15
		Unfavorable	3,500	Switchgrass	10
				Little bluestem	5
				Tall dropseed	5
				Eastern gamagrass	5
				Prairie cordgrass	5
				Western wheatgrass	5
Oa*:					
Ortello	Sandy	Favorable	3,750	Sand bluestem	20
		Normal	3,250	Little bluestem	20
		Unfavorable	2,500	Prairie sandreed	10
				Needleandthread	10
				Switchgrass	5
				Western wheatgrass	5
				Blue grama	5
				Sedge	5
				Indiangrass	5
Wells	Loamy Upland	Favorable	5,500	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5
				Sedge	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Sb: Solomon	Clay Lowland	Favorable	8,500	Big bluestem	35
		Normal	6,000	Indiangrass	15
		Unfavorable	3,500	Switchgrass	10
				Prairie cordgrass	5
				Tall dropseed	5
				Western wheatgrass	5
				Little bluestem	5
				Sideoats grama	5
				Eastern gamagrass	5
Sc, Sd: Sutphen	Clay Lowland	Favorable	7,500	Big bluestem	35
		Normal	5,500	Indiangrass	15
		Unfavorable	3,500	Switchgrass	10
				Little bluestem	5
				Prairie cordgrass	5
				Tall dropseed	5
				Western wheatgrass	5
				Sideoats grama	5
				Eastern gamagrass	5
Va, Vb: Valentine	Sands	Favorable	5,000	Prairie sandreed	10
		Normal	4,000	Sand bluestem	25
		Unfavorable	3,000	Little bluestem	15
				Sand lovegrass	10
				Switchgrass	10
				Blue grama	5
				Sand dropseed	5
Wa: Wells	Loamy Upland	Favorable	5,500	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5
				Sedge	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ca: Carwile	American plum, fragrant sumac.	---	Eastern redcedar, Russian mulberry.	Ponderosa pine, honeylocust, green ash.	Eastern cottonwood.
Cb, Cc: Clime	Fragrant sumac, Siberian peashrub.	Eastern redcedar, Rocky Mountain juniper, Russian-olive.	Ponderosa pine, Siberian elm, osageorange.	---	---
Cd*:					
Clime	Fragrant sumac, Siberian peashrub.	Eastern redcedar, Rocky Mountain juniper, Russian-olive.	Ponderosa pine, Siberian elm, osageorange.	---	---
Sogn.					
Ce, Cf, Cg: Crete	Fragrant sumac, Siberian peashrub.	Eastern redcedar, Autumn-olive, Russian-olive.	Green ash, common hackberry, honeylocust, Russian mulberry.	Ponderosa pine, Austrian pine, Scotch pine.	---
Da: Detroit	American plum, fragrant sumac.	Washington hawthorn, crabapple.	Russian mulberry, osageorange.	Green ash, eastern redcedar, ponderosa pine, common hackberry, honeylocust.	Eastern cottonwood, Siberian elm.
Ea: Elsmere	Fragrant sumac, American plum.	---	Eastern redcedar, Russian mulberry, common hackberry.	Green ash, honeylocust.	Eastern cottonwood.
Fa*. Fluvaquents					
Ga: Geary	Fragrant sumac, American plum.	Autumn-olive, Russian-olive.	Eastern redcedar, common hackberry, osageorange, green ash.	---	Siberian elm.
Ha, Hb: Hobbs	American plum, fragrant sumac.	Washington hawthorn, crabapple.	Eastern redcedar, Russian mulberry, common hackberry.	Ponderosa pine, Austrian pine, honeylocust, green ash, silver maple.	Eastern cottonwood, Siberian elm.
Ia, Ib: Irwin	Fragrant sumac, Siberian peashrub.	Eastern redcedar, Russian-olive.	Siberian elm, osageorange.	Ponderosa pine.	---
La*:					
Lancaster	Fragrant sumac, American plum.	Autumn-olive, Russian-olive.	Eastern redcedar, osageorange, common hackberry, green ash.	---	Siberian elm.
Hedville.					
Ma: McCook	American plum, fragrant sumac.	Washington hawthorn, crabapple.	Eastern redcedar, Russian mulberry, common hackberry.	Ponderosa pine, Austrian pine, green ash, honeylocust.	Eastern cottonwood, Siberian elm.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
Mb: Muir	American plum, fragrant sumac.	Washington hawthorn, crabapple.	Russian mulberry, Russian-olive, eastern redcedar, common hackberry.	Ponderosa pine, Austrian pine, green ash, honeylocust.	Eastern cottonwood, Siberian elm.
Oa*:					
Ortello	Fragrant sumac, American plum.	Amur honeysuckle	Eastern redcedar, Russian mulberry.	Ponderosa pine, Austrian pine, green ash, honeylocust.	Eastern cottonwood, Siberian elm.
Wells	Fragrant sumac, American plum.	Amur honeysuckle	Eastern redcedar, osageorange, common hackberry, Russian-olive.	Ponderosa pine, Austrian pine.	Siberian elm, eastern cottonwood.
Qa*. Quarries					
Sb: Solomon	American plum, fragrant sumac.	Osageorange, Russian-olive, common chokecherry.	Eastern redcedar, common hackberry.	Golden willow, honeylocust, silver maple.	Eastern cottonwood.
Sc, Sd: Sutphen	Fragrant sumac, American plum.	Osageorange, Russian-olive.	Eastern redcedar, Austrian pine, common hackberry.	Golden willow, honeylocust, silver maple.	Eastern cottonwood.
Va, Vb: Valentine	Siberian peashrub.	---	Eastern redcedar, Austrian pine, ponderosa pine, Scotch pine, common hackberry.	---	---
Wa: Wells	Fragrant sumac, American plum.	Amur honeysuckle	Eastern redcedar, osageorange, common hackberry, Russian-olive.	Ponderosa pine, Austrian pine.	Siberian elm, eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ca: Carwile	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.
Cb: Clime	Moderate: too clayey, depth to rock.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Cc: Clime	Moderate: too clayey, slope, depth to rock.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength.
Cd*:					
Clime	Moderate: too clayey, slope, depth to rock.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength.
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Ce, Cf, Cg: Crete	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell,	Severe: shrink-swell, low strength.
Da: Detroit	Moderate: too clayey, floods.	Severe: shrink-swell, floods.	Severe: shrink-swell, floods.	Severe: shrink-swell, floods.	Severe: shrink-swell, low strength.
Ea: Elsmere	Severe: wetness, cutbanks cave.	Severe: floods.	Severe: wetness, floods.	Severe: floods.	Moderate: wetness, frost action, floods.
Fa*. Fluvaquents					
Ga: Geary	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength.
Ha, Hb: Hobbs	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, low strength.
Ia, Ib: Irwin	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
La*:					
Lancaster	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope, depth to rock.	Severe: slope.	Severe: low strength.
Hedville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.
Ma: McCook	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Mb: Muir	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
Oa*:					
Ortello	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.
Wells	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Qa*. Quarries					
Sb: Solomon	Severe: floods, wetness, too clayey.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, floods.
Sc, Sd: Sutphen	Severe: floods, too clayey.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: low strength, shrink-swell, floods.
Va: Valentine	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Vb: Valentine	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Wa: Wells	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," and "fair." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ca: Carwile	Severe: percs slowly, wetness.	Slight	Severe: too clayey.	Severe: wetness.	Poor: too clayey, wetness.
Cb: Clime	Severe: percs slowly, depth to rock.	Moderate: depth to rock, slope.	Severe: too clayey, depth to rock.	Moderate: depth to rock.	Poor: too clayey, area reclaim.
Cc: Clime	Severe: percs slowly, depth to rock.	Severe: slope.	Severe: too clayey, depth to rock.	Moderate: slope, depth to rock.	Poor: too clayey, area reclaim.
Cd*:					
Clime	Severe: percs slowly, depth to rock.	Severe: slope.	Severe: too clayey, depth to rock.	Moderate: slope, depth to rock.	Poor: too clayey, area reclaim.
Sogn	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Ce: Crete	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Cf, Cg: Crete	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Da: Detroit	Severe: percs slowly.	Slight	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
Ea: Elsmere	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: too sandy, seepage.
Fa*. Fluvaquents					
Ga: Geary	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Ha, Hb: Hobbs	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
Ia, Ib: Irwin	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
La*:					
Lancaster	Severe: depth to rock.	Severe: slope.	Severe: depth to rock.	Moderate: slope, depth to rock.	Poor: area reclaim.
Hedville	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Ma: McCook	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.

See footnote at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Mb------------------ Muir	Moderate: floods.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Good.
Oa*:					
Ortello------------	Slight-----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
Wells--------------	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Qa*. Quarries					
Sb------------------ Solomon	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness, too clayey.
Sc, Sd-------------- Sutphen	Severe: percs slowly, floods.	Severe: floods.	Severe: floods, too clayey.	Severe: floods.	Poor: too clayey.
Va------------------ Valentine	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
Vb------------------ Valentine	Slight-----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
Wa------------------ Wells	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ca--------------------- Carwile	Poor: low strength, shrink-swell, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Cb--------------------- Clime	Poor: low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.
Cc--------------------- Clime	Poor: low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer, slope.
Cd*:				
Clime-----------------	Poor: low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer, slope.
Sogn------------------	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim.
Ce, Cf, Cg------------- Crete	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.
Da--------------------- Detroit	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Ea--------------------- Elsmere	Fair: wetness.	Fair: excess fines.	Unsuited: excess fines.	Good.
Fa*. Fluvaquents				
Ga--------------------- Geary	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Ha, Hb----------------- Hobbs	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Ia, Ib----------------- Irwin	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
La*:				
Lancaster-------------	Poor: area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, area reclaim, slope.
Hedville--------------	Poor: thin layer, area reclaim.	Unsuited: thin layer, excess fines.	Unsuited: thin layer, excess fines.	Fair: area reclaim, slope.
Ma--------------------- McCook	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Mb--------------------- Muir	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Oa*:				
Ortello	Good	Fair: excess fines.	Unsuited: excess fines.	Good.
Wells	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Qa*. Quarries				
Sb Solomon	Poor: low strength, shrink-swell, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey, wetness.
Sc Sutphen	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
Sd Sutphen	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Va Valentine	Good	Good	Unsuited: excess fines.	Fair: slope, too sandy.
Vb Valentine	Good	Good	Unsuited: excess fines.	Fair: too sandy.
Wa Wells	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ca: Carwile	Favorable	Wetness	Percs slowly	Wetness, percs slowly.	Not needed	Percs slowly, wetness.
Cb: Clime	Depth to rock	Thin layer, hard to pack.	Not needed	Droughty, rooting depth.	Favorable	Depth to rock, percs slowly.
Cc: Clime	Slope, depth to rock.	Thin layer, hard to pack.	Not needed	Droughty, rooting depth.	Favorable	Slope, depth to rock, percs slowly.
Cd*:						
Clime	Slope, depth to rock.	Thin layer, hard to pack.	Not needed	Droughty, rooting depth, slope.	Slope	Slope, depth to rock, percs slowly.
Sogn	Slope, depth to rock.	Thin layer	Not needed	Droughty, rooting depth, slope.	Depth to rock	Droughty, rooting depth.
Ce: Crete	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Not needed	Percs slowly, erodes easily.
Cf, Cg: Crete	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Percs slowly, erodes easily.
Da: Detroit	Favorable	Favorable	Not needed	Percs slowly	Not needed	Percs slowly, erodes easily.
Ea: Elsmere	Seepage	Seepage, piping, wetness.	Favorable	Wetness, soil blowing, droughty.	Not needed	Droughty.
Fa*. Fluvaquents						
Ga: Geary	Favorable	Favorable	Not needed	Favorable	Favorable	Favorable.
Ha, Hb: Hobbs	Seepage	Favorable	Not needed	Floods	Not needed	Favorable.
Ia, Ib: Irwin	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Erodes easily, percs slowly.
La*:						
Lancaster	Slope, depth to rock, seepage.	Thin layer	Not needed	Slope, rooting depth.	Favorable	Slope, depth to rock.
Hedville	Slope, depth to rock, seepage.	Thin layer	Not needed	Slope, rooting depth, droughty.	Depth to rock	Slope, droughty, rooting depth.
Ma: McCook	Seepage	Piping	Not needed	Floods	Not needed	Favorable.
Mb: Muir	Seepage	Favorable	Not needed	Favorable	Not needed	Favorable.
Oa*:						
Ortello	Seepage	Seepage	Not needed	Soil blowing	Soil blowing	Favorable.
Wells	Seepage	Favorable	Not needed	Soil blowing	Soil blowing	Favorable.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Qa*. Quarries						
Sb----------------- Solomon	Favorable------	Wetness, hard to pack.	Percs slowly, floods.	Wetness, slow intake, percs slowly, floods.	Not needed-----	Wetness, percs slowly.
Sc, Sd------------ Sutphen	Favorable------	Hard to pack---	Not needed-----	Floods, slow intake, percs slowly.	Not needed-----	Percs slowly.
Va----------------- Valentine	Seepage, slope.	Seepage, piping.	Not needed-----	Fast intake, soil blowing, droughty.	Slope, soil blowing.	Slope, droughty.
Vb----------------- Valentine	Seepage---------	Seepage, piping.	Not needed-----	Fast intake, soil blowing, droughty.	Soil blowing---	Droughty.
Wa----------------- Wells	Seepage---------	Favorable------	Not needed-----	Favorable------	Favorable------	Favorable.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ca---------- Carwile	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Cb---------- Clime	Slight----------	Slight----------	Moderate: slope, too clayey.	Slight.
Cc---------- Clime	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Cd*:				
Clime----------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Sogn----------	Severe: depth to rock.	Slight----------	Severe: depth to rock, slope.	Slight.
Ce---------- Crete	Slight----------	Slight----------	Slight----------	Slight.
Cf, Cg---------- Crete	Slight----------	Slight----------	Moderate: slope, too clayey.	Slight.
Da---------- Detroit	Severe: floods.	Slight----------	Slight----------	Slight.
Ea---------- Elsmere	Severe: floods.	Moderate: wetness.	Moderate: wetness.	Slight.
Fa*. Fluvaquents				
Ga---------- Geary	Slight----------	Slight----------	Moderate: slope.	Slight.
Ha---------- Hobbs	Severe: floods.	Slight----------	Moderate: floods.	Slight.
Hb---------- Hobbs	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
Ia, Ib---------- Irwin	Moderate: percs slowly.	Slight----------	Moderate: percs slowly, slope.	Slight.
La*:				
Lancaster----------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Hedville----------	Severe: depth to rock.	Moderate: slope.	Severe: slope, depth to rock.	Slight.
Ma---------- McCook	Severe: floods.	Slight----------	Moderate: floods.	Slight.
Mb---------- Muir	Severe: floods.	Slight----------	Slight----------	Slight.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Oa*:				
Ortello	Slight	Slight	Moderate: slope.	Slight.
Wells	Slight	Slight	Moderate: slope.	Slight.
Qa*. Quarries				
Sb Solomon	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Sc Sutphen	Severe: floods.	Slight	Moderate: too clayey, floods, percs slowly.	Slight.
Sd Sutphen	Severe: floods.	Moderate: too clayey.	Severe: too clayey.	Moderate: too clayey.
Va Valentine	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
Vb Valentine	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Wa Wells	Slight	Slight	Moderate: slope.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Ca----------------- Carwile	Fair	Good	Good	Good	Good	Fair	Good	Fair	Good.
Cb, Cc------------- Clime	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Cd*:									
Clime--------------	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Sogn---------------	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Ce, Cf------------- Crete	Good	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Good.
Cg----------------- Crete	Fair	Good	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
Da----------------- Detroit	Good	Good	Good	Good	Good	Good	Good	Good	Good.
Ea----------------- Elsmere	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good.
Fa*. Fluvaquents									
Ga----------------- Geary	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Ha----------------- Hobbs	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Hb----------------- Hobbs	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Ia----------------- Irwin	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Ib----------------- Irwin	Fair	Good	Good	Fair	Poor	Poor	Fair	Poor	Fair.
La*:									
Lancaster----------	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Hedville-----------	Very poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Ma----------------- McCook	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Mb----------------- Muir	Good	Good	Good	Good	Poor	Very poor	Good	Very poor	Good.
Oa*:									
Ortello------------	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Wells--------------	Good	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Qa*. Quarries									
Sb----------------- Solomon	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	---

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Sc, Sd-------------- Sutphen	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	---
Va, Vb-------------- Valentine	Poor	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Wa------------------ Wells	Good	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Ca----------------- Carwile	0-7	Loam------------	ML, CL, CL-ML, SM	A-4	0	100	98-100	94-100	36-85	<30	NP-10
	7-14	Clay loam, sandy clay loam.	CL, SC	A-6, A-7	0	100	100	90-100	36-90	35-50	14-26
	14-31	Clay loam, clay, sandy clay.	CL, CH, SC	A-6, A-7	0	100	100	90-100	40-95	35-70	14-38
	31-60	Clay loam, sandy clay loam, clay.	CL, CH, SC	A-4, A-6, A-7	0	100	100	90-100	36-95	25-70	7-38
Cb, Cc------------- Clime	0-10	Silty clay loam	CL, CH	A-7, A-6	0-20	90-100	90-100	85-100	80-95	38-60	18-30
	10-19	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	85-95	38-60	18-35
	19-27	Silty clay, clay	CL, CH	A-7, A-6	0	85-100	80-100	75-95	60-90	30-55	11-30
	27	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cd*: Clime--------------	0-10	Silty clay loam	CL, CH	A-7, A-6	0-20	90-100	90-100	85-100	80-95	38-60	18-30
	10-19	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	85-95	38-60	18-35
	19-27	Silty clay, clay	CL, CH	A-7, A-6	0	85-100	80-100	75-95	60-90	30-55	11-30
	27	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sogn--------------	0-14	Silt loam-------	CL	A-6, A-7	0-10	85-100	85-100	85-100	80-95	25-45	11-23
	14	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ce, Cf, Cg--------- Crete	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-30
	11-30	Silty clay------	CH	A-7	0	100	100	100	95-100	50-65	25-38
	30-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	100	95-100	35-55	18-35
Da----------------- Detroit	0-8	Silt loam-------	CL	A-6, A-4	0	100	100	95-100	85-95	25-40	8-20
	8-45	Silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	45-55	20-30
	45-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	18-24
Ea----------------- Elsmere	0-12	Fine sandy loam	SM, SM-SC	A-4, A-2	0	100	100	70-85	30-50	<25	NP-5
	12-60	Fine sand, loamy fine sand, loamy sand.	SP-SM, SM	A-2, A-3	0	100	100	60-100	5-30	---	NP
Fa*. Fluvaquents											
Ga----------------- Geary	0-13	Silt loam-------	ML, CL	A-4, A-6	0	100	100	96-100	80-98	25-40	2-15
	13-52	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	96-100	85-98	35-50	15-25
	52-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	85-98	30-45	11-20
Ha, Hb------------- Hobbs	0-8	Silt loam-------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	8-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
Ia, Ib------------- Irwin	0-9	Silty clay loam	CL	A-6	0	100	100	95-100	90-100	30-40	11-20
	9-39	Silty clay, clay	CH	A-7-6	0	100	100	95-100	90-100	50-65	25-40
	39-60	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	100	100	95-100	90-100	40-60	20-40

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
La*:											
Lancaster	0-11	Loam	CL-ML, CL	A-4, A-6	0	100	100	85-100	50-85	20-35	5-15
	11-24	Sandy clay loam, clay loam, loam.	CL, SC	A-4, A-6	0	100	100	80-90	40-60	20-40	8-25
	24-36	Clay loam, loam, sandy clay loam.	CL-ML, SC, SM-SC, CL	A-4, A-6	0	100	100	80-100	40-80	20-40	5-15
	36	Weathered bedrock, unweathered bedrock.	---	---	---	---	---	---	---	---	---
Hedville	0-16	Loam, fine sandy loam.	SM, ML, SC, CL	A-4	0-30	70-100	70-100	50-85	35-70	<26	NP-8
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ma McCook	0-26	Silt loam	ML, CL, CL-ML	A-4	0	100	100	95-100	60-98	20-35	2-10
	26-60	Very fine sandy loam, silt loam, loam.	ML, CL, CL-ML	A-4	0	100	100	95-100	55-98	<20	NP-10
Mb Muir	0-22	Silt loam	CL	A-4, A-6	0	100	100	95-100	85-100	25-40	8-20
	22-60	Silt loam, silty clay loam, loam.	CL	A-4, A-6	0	100	100	95-100	85-100	25-40	8-20
Oa*:											
Ortello	0-16	Fine sandy loam	SM, ML	A-4	0	100	100	70-85	40-55	<20	NP
	16-46	Fine sandy loam, sandy loam.	SM, ML	A-4	0	100	100	70-85	40-55	<20	NP
	46-60	Fine sand, loamy fine sand.	SP-SM, SM	A-3, A-2	0	100	100	50-75	5-35	---	NP
Wells	0-8	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-4	0	100	100	85-100	36-60	<25	NP-5
	8-44	Clay loam, sandy clay loam, loam.	SC, CL	A-4, A-6, A-7	0	100	100	80-100	40-85	30-50	8-25
	44-60	Clay loam, sandy clay loam, sandy loam.	SC, CL, ML, SM	A-4, A-6	0	100	100	80-100	36-85	20-40	NP-15
Qa*. Quarries											
Sb Solomon	0-10	Silty clay	CH	A-7	0	100	100	95-100	90-100	50-75	35-50
	10-60	Silty clay, clay	CH	A-7	0	100	100	95-100	90-100	50-75	25-50
Sc Sutphen	0-12	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	90-100	35-55	20-35
	12-48	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	48-60	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	41-70	20-40
Sd Sutphen	0-7	Silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	7-48	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	48-60	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	41-70	20-40

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Va, Vb------------- Valentine	0-15	Loamy fine sand	SM, SP-SM, SP	A-2, A-3	0	100	100	95-100	2-35	---	NP
	15-60	Fine sand, loamy fine sand.	SM, SP-SM, SP	A-2, A-3	0	100	100	95-100	2-20	---	NP
Wa----------------- Wells	0-19	Loam------------	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-85	20-30	5-15
	19-44	Clay loam, sandy clay loam.	SC, CL	A-4, A-6, A-7	0	100	100	80-100	40-85	30-50	8-25
	44-60	Clay loam, sandy clay loam, sandy loam.	SC, CL, ML, SM	A-4, A-6	0	100	100	80-100	35-85	20-40	NP-15

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Ca---------------- Carwile	0-7	0.6-2.0	0.11-0.20	5.1-7.3	<2	Low--------	0.32	5	6
	7-14	0.2-2.0	0.12-0.20	5.1-7.3	<2	Moderate	0.32		
	14-31	0.06-0.2	0.12-0.20	6.1-8.4	<2	High------	0.37		
	31-60	0.2-2.0	0.12-0.20	6.6-8.4	<2	High------	0.32		
Cb, Cc------------ Clime	0-10	0.06-0.6	0.12-0.20	7.4-8.4	<2	Moderate	0.28	3	4
	10-19	0.06-0.6	0.12-0.18	7.9-8.4	<2	Moderate	0.28		
	19-27	0.06-0.6	0.11-0.15	7.9-8.4	<2	Moderate	0.28		
	27	---	---	---	---	----------	---		
Cd*:									
Clime------------	0-10	0.06-0.6	0.12-0.20	7.4-8.4	<2	Moderate	0.28	3	4
	10-19	0.06-0.6	0.12-0.18	7.9-8.4	<2	Moderate	0.28		
	19-27	0.06-0.6	0.11-0.15	7.9-8.4	<2	Moderate	0.28		
	27	---	---	---	---	----------	---		
Sogn-------------	0-14	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.28	1	4L
	14	---	---	---	---	----------	---		
Ce, Cf, Cg-------- Crete	0-11	0.2-0.6	0.21-0.23	5.6-6.0	<2	High------	0.37	4	7
	11-30	0.06-0.2	0.12-0.14	6.1-7.3	<2	High------	0.37		
	30-60	0.2-0.6	0.18-0.20	7.4-7.8	<2	High------	0.37		
Da---------------- Detroit	0-8	0.2-0.6	0.22-0.24	6.1-7.3	<2	Low--------	0.28	5	6
	8-45	0.06-0.2	0.12-0.15	6.6-7.8	<2	High------	0.28		
	45-60	0.2-0.6	0.18-0.20	6.6-7.8	<2	Moderate	0.28		
Ea---------------- Elsmere	0-12	2.0-6.0	0.14-0.17	5.6-7.8	<2	Low--------	0.17	5	3
	12-60	6.0-20	0.06-0.08	5.6-7.8	<2	Low--------	0.17		
Fa*. Fluvaquents									
Ga---------------- Geary	0-13	0.6-2.0	0.18-0.24	5.6-6.5	<2	Low--------	0.32	5	6
	13-52	0.2-2.0	0.17-0.20	6.1-7.8	<2	Moderate	0.43		
	52-60	0.6-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.43		
Ha, Hb------------ Hobbs	0-8	0.6-2.0	0.21-0.24	6.1-7.8	<2	Low--------	0.32	5	6
	8-60	0.6-2.0	0.18-0.22	6.1-8.4	<2	Low--------	0.32		
Ia, Ib------------ Irwin	0-9	0.2-2.0	0.18-0.23	5.6-7.3	<2	Moderate	0.37	4	7
	9-39	<0.06	0.10-0.15	5.6-8.4	<2	High------	0.37		
	39-60	<0.2	0.09-0.15	6.6-8.4	<2	High------	0.37		
La*:									
Lancaster--------	0-11	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low--------	0.28	4	5
	11-24	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28		
	24-36	0.6-2.0	0.15-0.19	6.1-7.3	<2	Low--------	0.28		
	36	---	---	---	---	----------	---		
Hedville---------	0-16	0.6-2.0	0.14-0.20	5.6-7.3	<2	Low--------	0.24	2	5
	16	---	---	---	---	----------	---		
Ma---------------- McCook	0-26	0.6-2.0	0.19-0.22	7.4-7.8	<2	Low--------	0.32	5	6
	26-60	0.6-2.0	0.17-0.20	7.9-8.4	<2	Low--------	0.43		
Mb---------------- Muir	0-22	0.6-2.0	0.20-0.23	5.6-7.8	<2	Low--------	0.32	5	6
	22-60	0.6-2.0	0.18-0.22	6.1-7.8	<2	Low--------	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Oa*:									
Ortello----------	0-16	2.0-6.0	0.16-0.18	6.1-6.5	<2	Low--------	0.20	4	3
	16-46	2.0-6.0	0.15-0.17	6.6-7.3	<2	Low--------	0.20		
	46-60	6.0-20	0.05-0.10	6.6-7.8	<2	Low--------	0.20		
Wells------------	0-8	0.6-2.0	0.13-0.15	5.6-6.5	<2	Low--------	0.28	5	3
	8-44	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28		
	44-60	0.6-2.0	0.12-0.18	6.1-7.3	<2	Low--------	0.28		
Qa*. Quarries									
Sb---------------- Solomon	0-10	<0.06	0.11-0.15	7.4-8.4	<2	High-------	0.28	5	4
	10-60	<0.06	0.09-0.14	7.9-9.0	<2	High-------	0.28		
Sc---------------- Sutphen	0-12	<0.2	0.21-0.23	6.1-8.4	<2	High-------	0.28	5	7
	12-48	<0.06	0.10-0.14	6.6-8.4	<2	High-------	0.28		
	48-60	<0.2	0.10-0.18	7.4-8.4	<2	High-------	0.28		
Sd---------------- Sutphen	0-7	<0.06	0.11-0.14	6.1-8.4	<2	High-------	0.28	5	4
	7-48	<0.06	0.10-0.14	6.6-8.4	<2	High-------	0.28		
	48-60	<0.2	0.10-0.18	7.4-8.4	<2	High-------	0.28		
Va, Vb------------ Valentine	0-15	6.0-20	0.08-0.11	6.1-7.3	<2	Low--------	0.15	5	2
	15-60	6.0-20	0.06-0.08	6.1-7.3	<2	Low--------	0.15		
Wa---------------- Wells	0-19	0.6-2.0	0.20-0.22	5.6-6.5	<2	Low--------	0.28	5	5
	19-44	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28		
	44-60	0.6-2.0	0.12-0.18	6.1-7.3	<2	Low--------	0.28		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the Glossary explain terms such as "rare," "brief," "apparent," and "perched." The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Ca----------------- Carwile	D	None---------	---	---	0-2.0	Perched	Oct-Apr	>60	---	Moderate	High------	Moderate.
Cb, Cc------------- Clime	C	None---------	---	---	>6.0	---	---	20-40	Rippable	Moderate	High------	Low.
Cd*:												
Clime-------------	C	None---------	---	---	>6.0	---	---	20-40	Rippable	Moderate	High------	Low.
Sogn--------------	D	None---------	---	---	>6.0	---	---	4-20	Hard	Moderate	Low-------	Low.
Ce, Cf, Cg--------- Crete	D	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Da----------------- Detroit	C	Rare---------	---	---	>6.0	---	---	>60	---	Low-------	High------	Low.
Ea----------------- Elsmere	A	Rare---------	---	---	1.5-2.5	Apparent	Apr-Jun	>60	---	Moderate	Moderate	Low.
Fa*---------------- Fluvaquents	D	Frequent-----	Brief to very long.	Apr-Oct	0-2.0	Apparent	Apr-Oct	>60	---	Moderate	High------	Low.
Ga----------------- Geary	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
Ha----------------- Hobbs	B	Occasional	Brief------	Apr-Sep	>6.0	---	---	>60	---	Moderate	Low-------	Low.
Hb----------------- Hobbs	B	Frequent-----	Brief------	Apr-Sep	>6.0	---	---	>60	---	Moderate	Low-------	Low.
Ia, Ib------------- Irwin	D	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
La*:												
Lancaster---------	B	None---------	---	---	>6.0	---	---	20-40	Rippable	Moderate	Low-------	Moderate.
Hedville----------	D	None---------	---	---	>6.0	---	---	4-20	Hard	Moderate	Low-------	Moderate.
Ma----------------- McCook	B	Occasional	Very brief	Apr-Jul	>6.0	---	---	>60	---	Moderate	Low-------	Low.
Mb----------------- Muir	B	Rare---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Low.
Oa*:												
Ortello-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Oa*:												
Wells	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.
Qa*. Quarries												
Sb Solomon	D	Occasional	Brief to long.	Nov-May	0-2.0	Apparent	Dec-May	>60	---	Moderate	High	Low.
Sc, Sd Sutphen	D	Occasional	Very brief	Mar-Sep	>6.0	---	---	>60	---	Low	High	Low.
Va, Vb Valentine	A	None	---	---	>6.0	---	---	>60	---	Low	Low	Low.
Wa Wells	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING TEST DATA

[Dashes indicate data were not available]

Soil name, report number, horizon, and depth in inches	Classification		Grain size distribution[1]							Liquid limit	Plasticity index	Moisture density[2]	
			Percentage passing sieve				Percentage smaller than--						
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Max. dry density	Optimum moisture
										Pct		Lb/ft3	Pct
Sutphen sic: (S75KS-041-001)													
Ap---------0 to 7	A-7-6(26)	CL-CH	100	100	99	97	72	49	36	50	23	117	23
A12--------7 to 17	A-7-6(40)	CH	100	100	100	98	75	47	27	61	35	115	25
C1--------33 to 48	A-7-6(37)	CH	100	100	99	96	65	41	27	59	33	116	21
Crete sicl: (S75KS-041-002)													
Ap---------0 to 8	A-6 (12)	CL	100	100	100	98	56	29	23	35	11	117	19
B21t------11 to 18	A-7-6(32)	CH	100	100	100	99	71	49	39	55	27	114	24
C1--------40 to 55	A-7-6(28)	CL	100	100	100	99	66	34	22	49	25	119	20
Geary sil: (S75KS-041-003)													
A11--------0 to 10	A-7-6(17)	ML	100	100	99	94	45	21	13	42	16	113	20
B21t------22 to 37	A-7-6(27)	CL	100	100	100	95	63	39	29	49	25	121	21
Cca-------52 to 60	A-6 (22)	CL	100	100	100	96	51	29	21	40	22	123	18
Muir sil: (S75KS-041-019)													
Ap---------0 to 7	A-6 (13)	CL	100	100	100	95	54	26	19	34	13	124	17
B2--------25 to 42	A-7-6(22)	CL	100	100	100	98	66	35	27	43	20	119	18
C1--------42 to 55	A-7-6(23)	CL	100	100	100	99	69	32	22	41	22	122	21

[1]Grain size distribution according to the AASHTO Designation T88-72, with the following variations: (1) all material is crushed in a laboratory steel-jawed crusher; (2) the sample is not soaked prior to dispersion; (3) dispersing time is 5 minutes at 7 p.s.i. using an Iowa air tube; and (4) AASHTO T-133-74 is followed except for sample size to obtain SpG for hydrometer analysis. Results by this procedure frequently may differ somewhat from results that would have been obtained by the Soil Survey Procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[2]Based on the Moisture-density Relations of Soils Using 5.5-lb. Rammer and 12-in Drop. AASHTO Designation T99-74, method A, with the following variations: (1) all material is crushed in a laboratory steel-jawed crusher after drying; and (2) no time is allowed for dispersion of moisture after mixing with the soil material.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
*Carwile	Fine, mixed, thermic Typic Argiaquolls
Clime	Fine, mixed, mesic Udic Haplustolls
Crete	Fine, montmorillonitic, mesic Pachic Argiustolls
Detroit	Fine, montmorillonitic, mesic Pachic Argiustolls
Elsmere	Sandy, mixed, mesic Aquic Haplustolls
Fluvaquents	Fine, montmorillonitic (calcareous), mesic Typic Fluvaquents
Geary	Fine-silty, mixed, mesic Udic Argiustolls
Hedville	Loamy, mixed, mesic Lithic Haplustolls
Hobbs	Fine-silty, mixed, nonacid, mesic Mollic Ustifluvents
Irwin	Fine, mixed, mesic Pachic Argiustolls
Lancaster	Fine-loamy, mixed, mesic Udic Argiustolls
McCook	Coarse-silty, mixed, mesic Fluventic Haplustolls
Muir	Fine-silty, mixed, mesic Pachic Haplustolls
Ortello	Coarse-loamy, mixed, mesic Udic Haplustolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Solomon	Fine, montmorillonitic (calcareous), mesic Vertic Haplaquolls
Sutphen	Fine, montmorillonitic, mesic Udertic Haplustolls
Valentine	Mixed, mesic Typic Ustipsamments
Wells	Fine-loamy, mixed, mesic Udic Argiustolls

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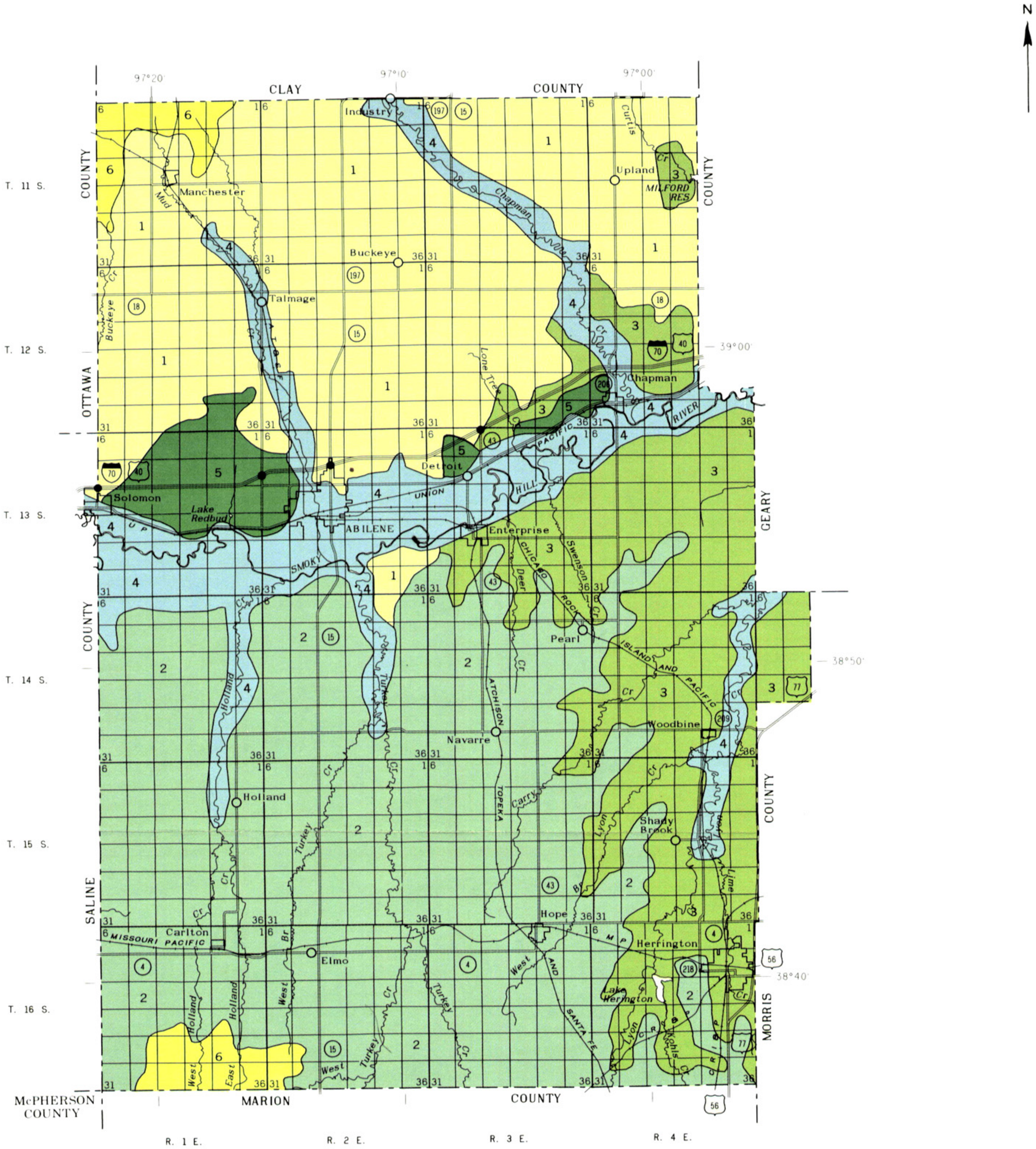


SOIL LEGEND

1. Crete–Irwin–Geary: Deep, nearly level to moderately sloping soils that have a silty surface layer; on uplands
2. Irwin–Clime: Deep and moderately deep, gently sloping to strongly sloping soils that have a silty surface layer; on uplands
3. Irwin–Clime–Sogn: Deep to shallow, gently sloping to moderately steep soils that have a silty surface layer; on uplands
4. Muir–Hobbs–Sutphen: Deep, nearly level soils that have a silty or clayey surface layer; on bottom lands
5. Valentine–Ortello–Wells: Deep, undulating and rolling soils that have a sandy or loamy surface layer; on uplands
6. Wells–Lancaster–Hedville: Deep to shallow, moderately sloping and strongly sloping soils that have a loamy surface layer; on uplands

Compiled 1979

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

DICKINSON COUNTY, KANSAS

Scale 1: 253,440

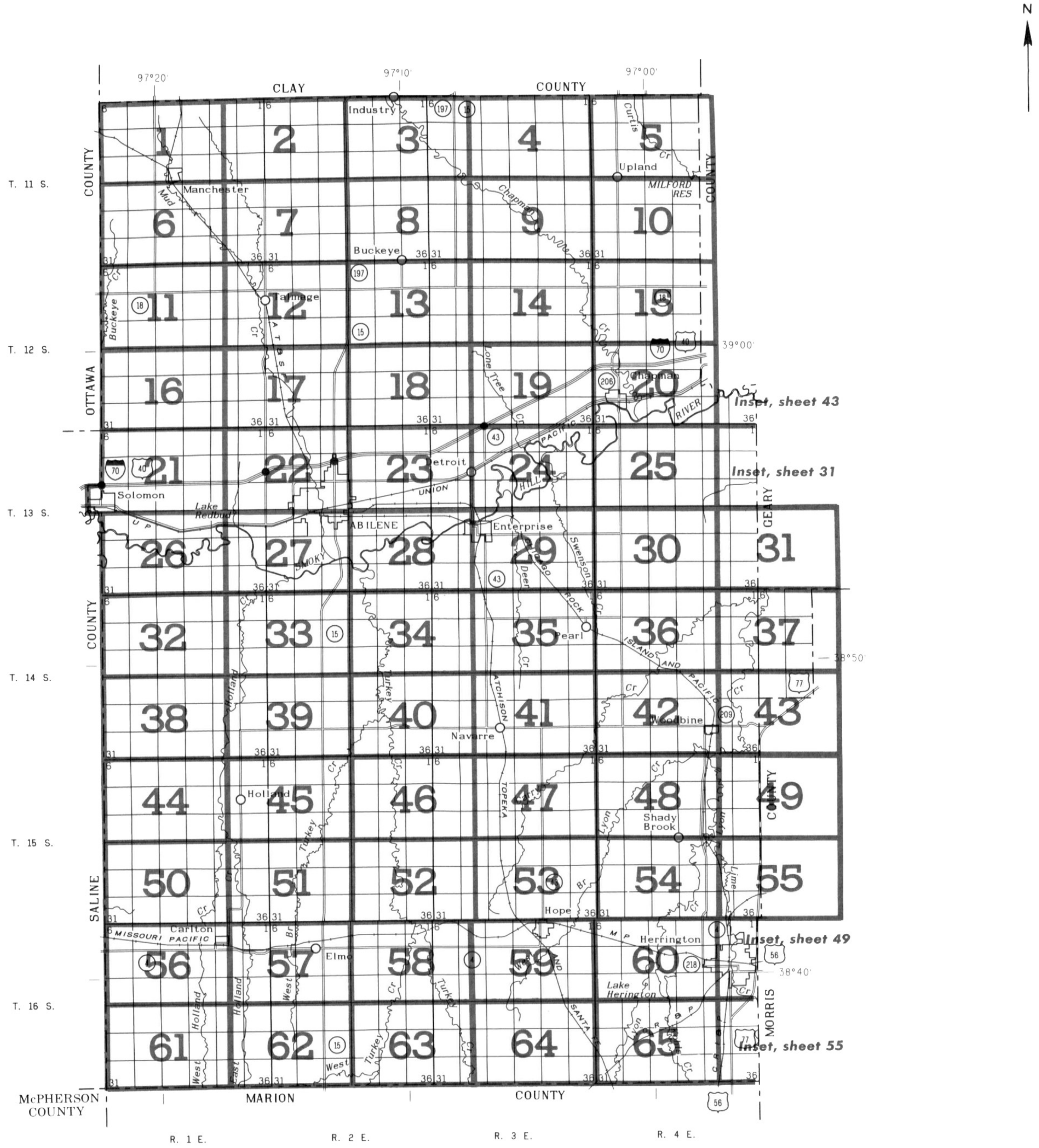
1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



Original text from each individual map sheet read:

This map is compiled on 1976 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

INDEX TO MAP SHEETS

DICKINSON COUNTY, KANSAS

Scale 1: 253,440

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

SYMBOL	NAME
Ca	Carwile loam
Cb	Clime silty clay loam, 2 to 6 percent slopes
Cc	Clime silty clay loam, 6 to 15 percent slopes
Cd	Clime—Sogn complex, 5 to 20 percent slopes
Ce	Crete silty clay loam, 0 to 1 percent slopes
Cf	Crete silty clay loam, 1 to 3 percent slopes
Cg	Crete silty clay loam, 3 to 7 percent slopes
Da	Detroit silt loam
Ea	Elsmere fine sandy loam
Fa	Fluvaquents, clayey
Ga	Geary silt loam, 2 to 7 percent slopes
Ha	Hobbs silt loam
Hb	Hobbs silt loam, channeled
Ia	Irwin silty clay loam, 1 to 3 percent slopes
Ib	Irwin silty clay loam, 3 to 7 percent slopes
La	Lancaster—Hedville loams, 3 to 15 percent slopes
Ma	McCook silt loam
Mb	Muir silt loam
Oa	Ortello—Wells fine sandy loams, undulating
Qa	Quarries
Sb	Solomon silty clay
Sc	Sutphen silty clay loam
Sd	Sutphen silty clay
Va	Valentine loamy fine sand, rolling
Vb	Valentine loamy fine sand, undulating
Wa	Wells loam, 3 to 7 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

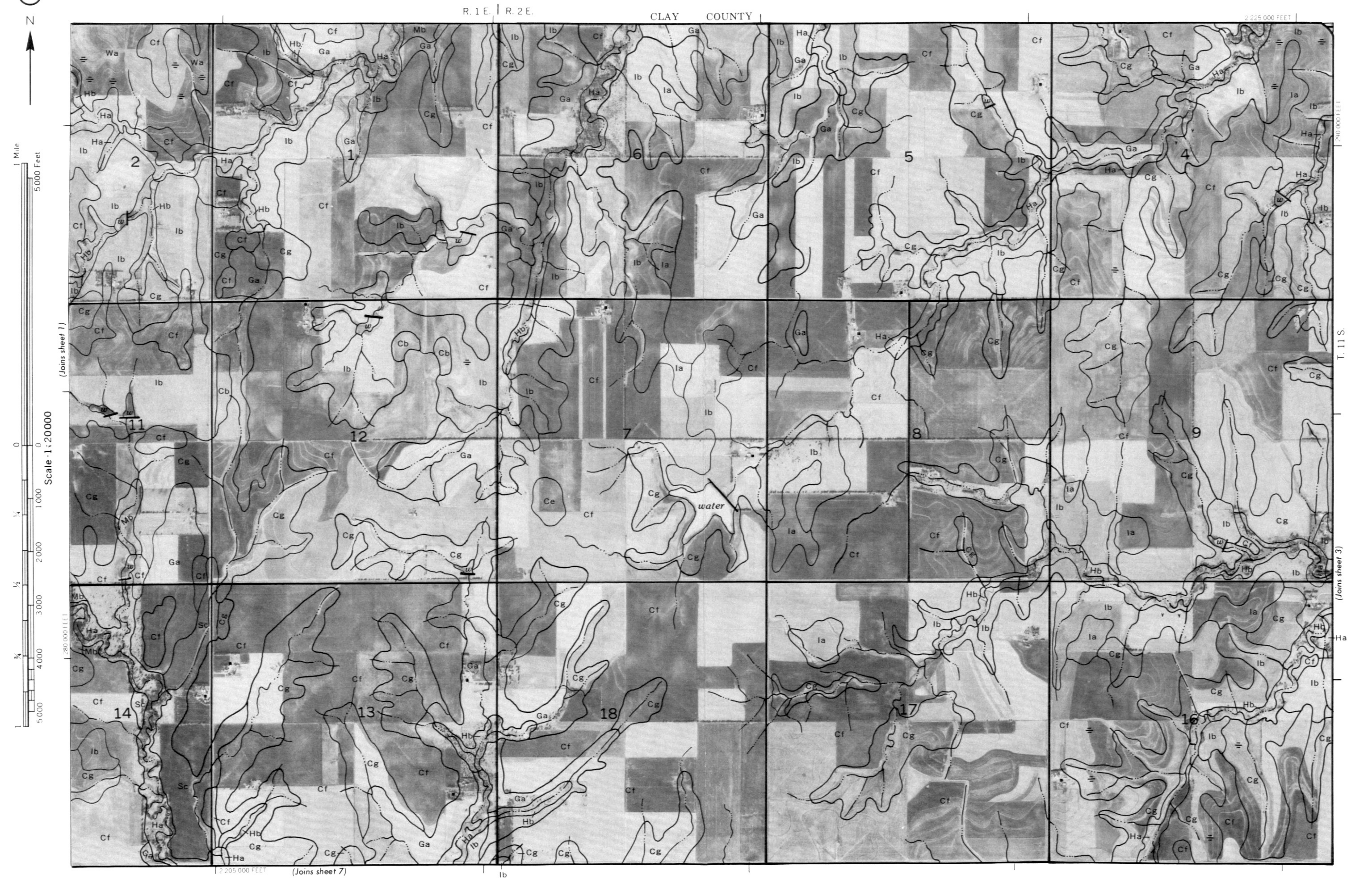
SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot


1
CLAY COUNTY
2 180 000 FEET
R. 1 E.
290 000 FEET
T. 11 S.
OTTAWA COUNTY
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 2)
(Joins sheet 6)
280 000 FEET
2 200 000 FEET
KEYSTONE CEMETERY
Manchester City Lake
Manchester
ATCHISON TOPEKA AND SANTA FE
water
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18

DICKINSON COUNTY, KANSAS — SHEET NUMBER 2



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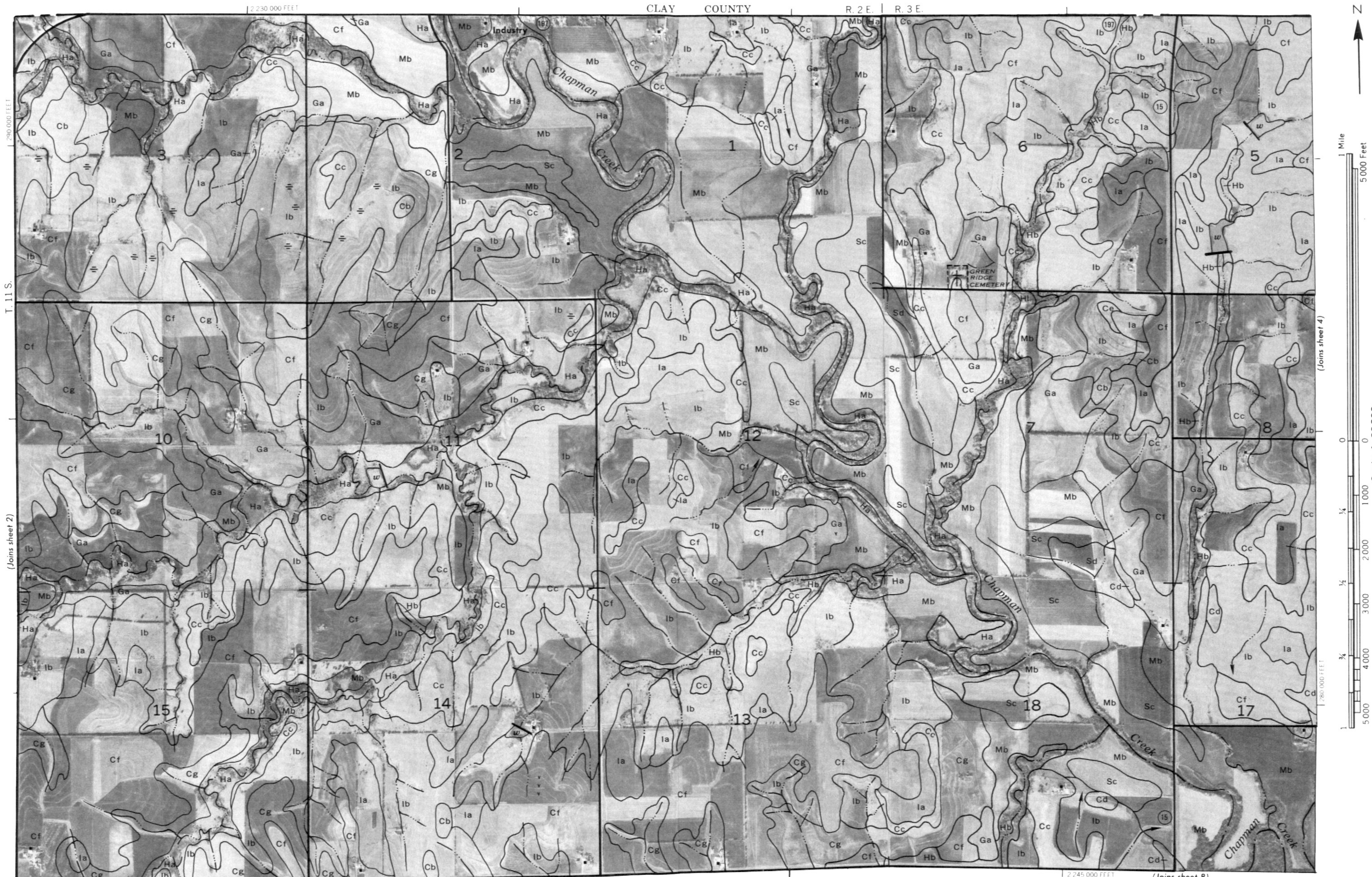

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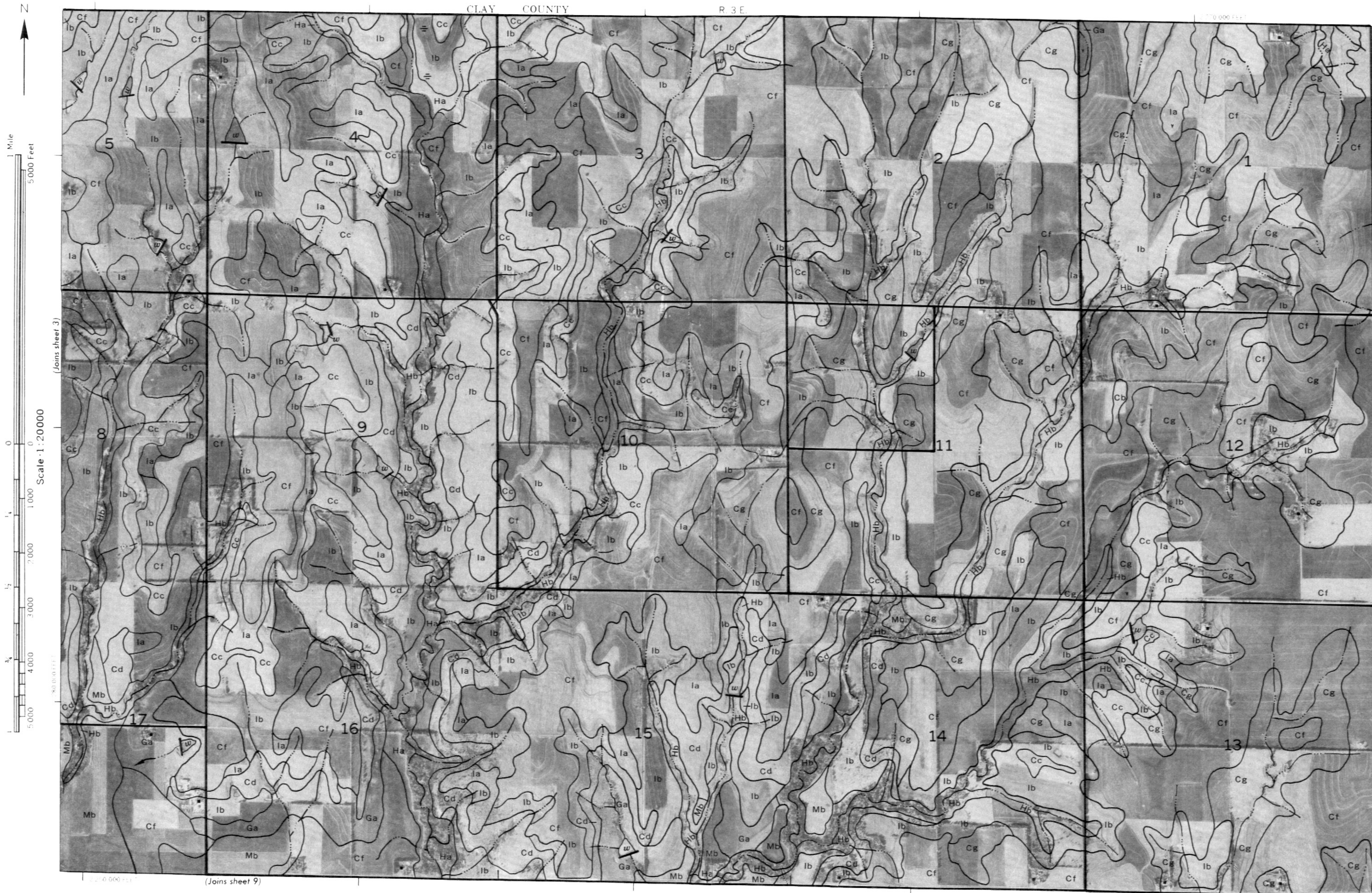

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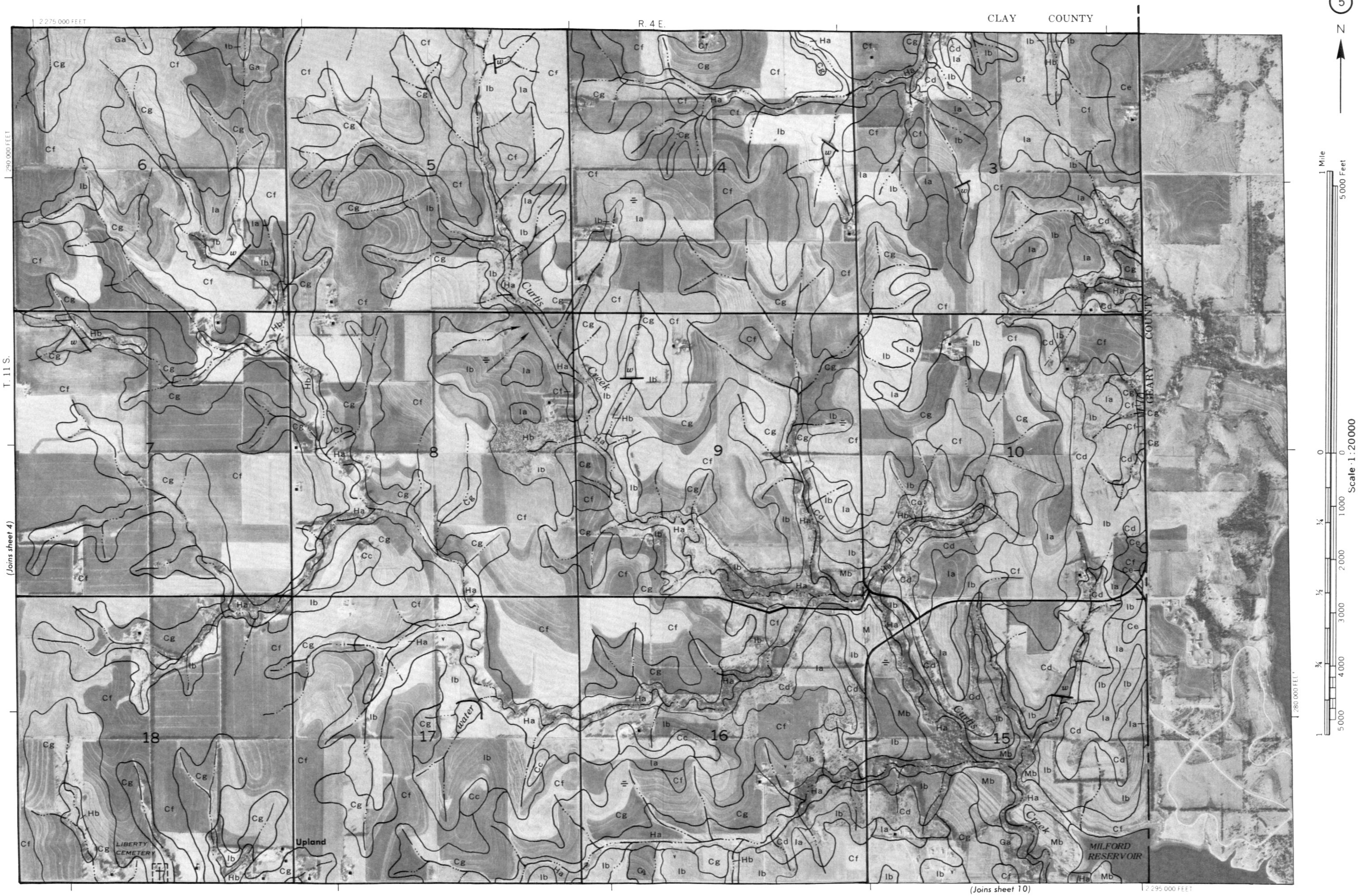

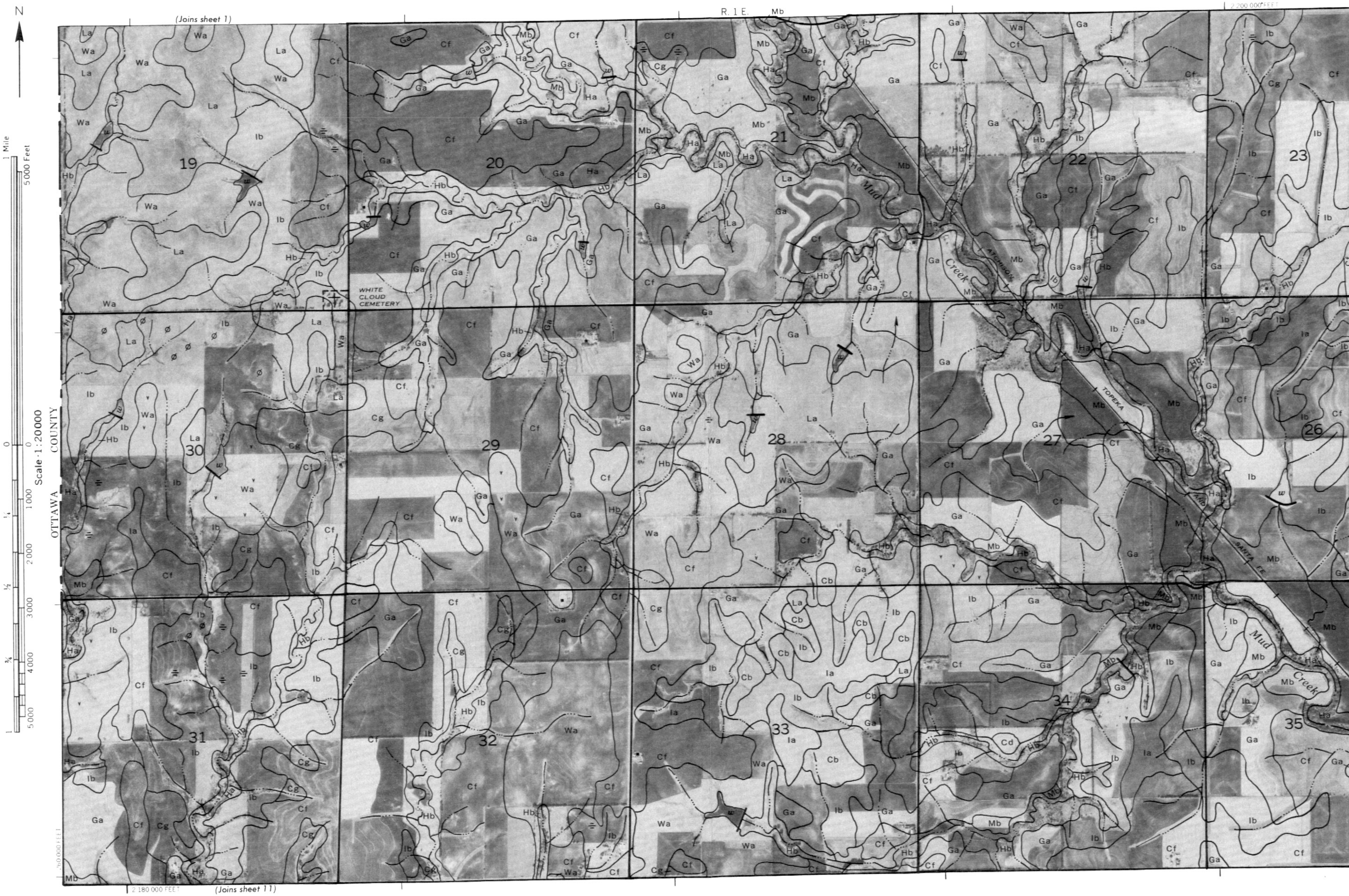
N
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R. 1 E.
2 200 000 FEET
275 000 FEET
T. 11 S.
(Joins sheet 7)
(Joins sheet 11)
2 180 000 FEET
250 000 FEET
OTTAWA COUNTY
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
WHITE CLOUD CEMETERY
Mud Creek
ATCHISON
TOPEKA
SANTA FE
19
20
21
22
23
26
27
28
29
30
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33
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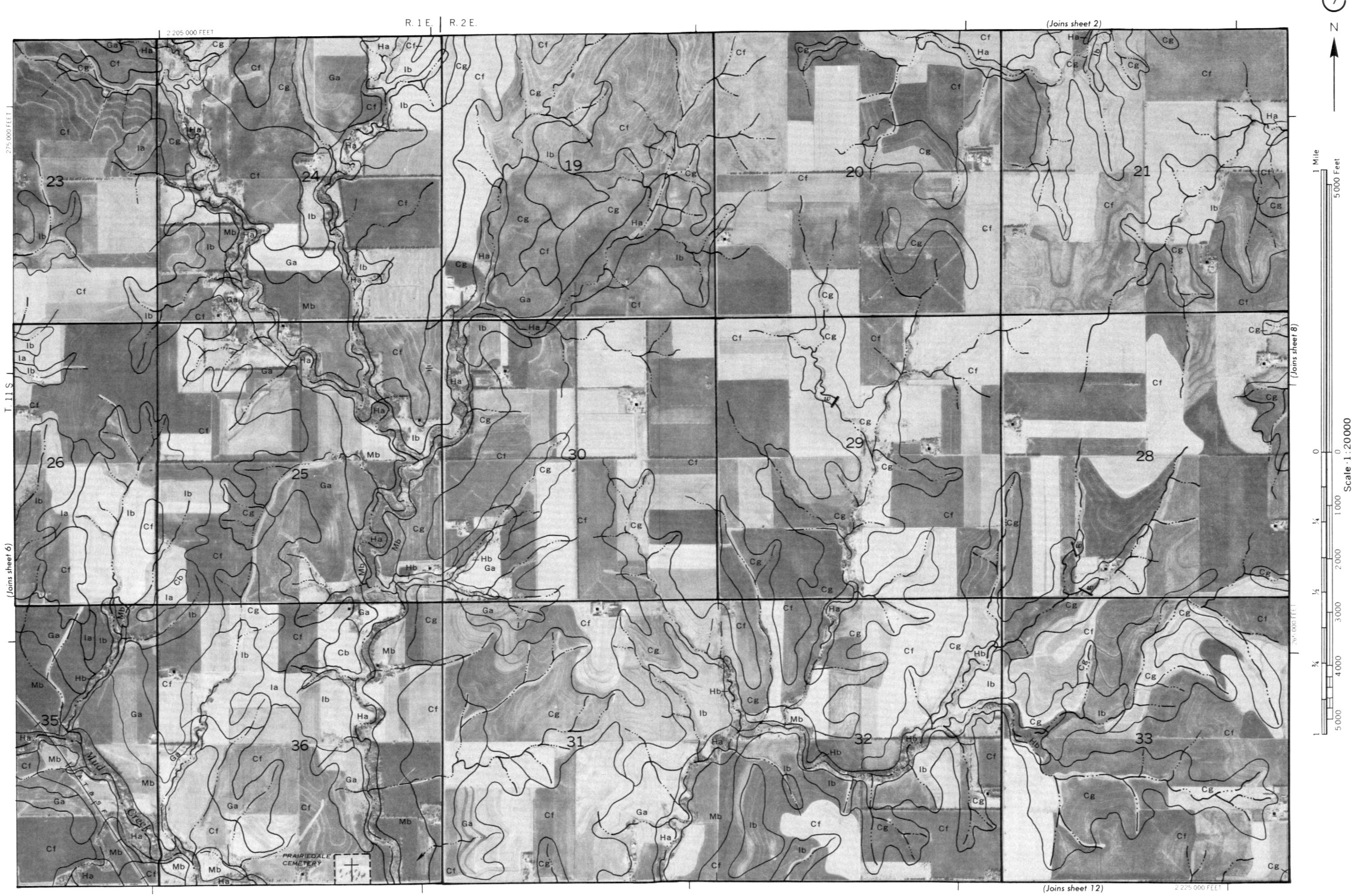
35
La
Wa
Ib
Ia
Cf
Cg
Cb
Cd
Ga
Ha
Hb
Mb


7
N
R. 1 E.
R. 2 E.
2 205 000 FEET
275 000 FEET
(Joins sheet 2)
(Joins sheet 8)
(Joins sheet 6)
(Joins sheet 12)
T. 11 S.
2 225 000 FEET
19
20
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24
25
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28
29
30
31
32
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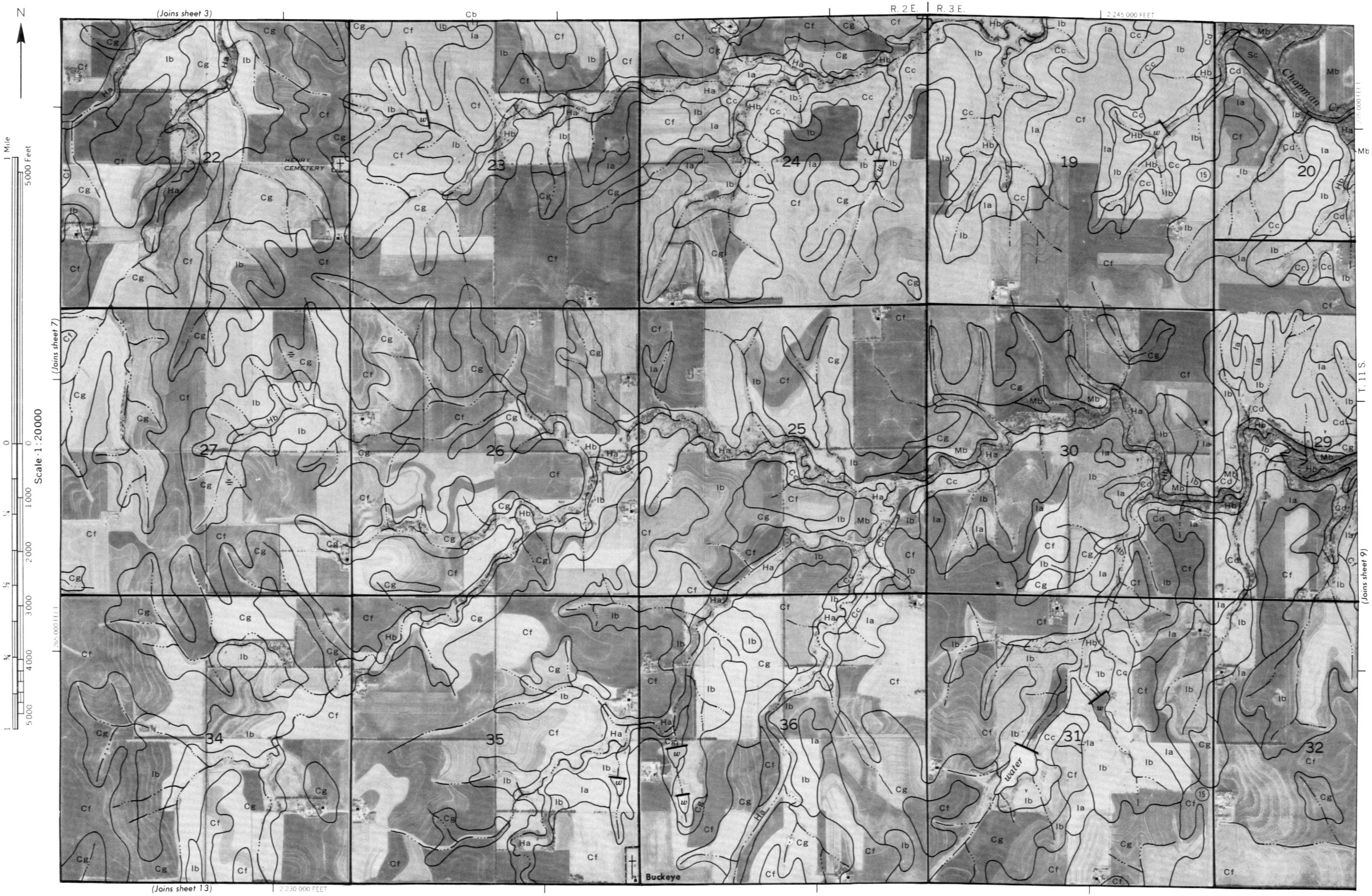
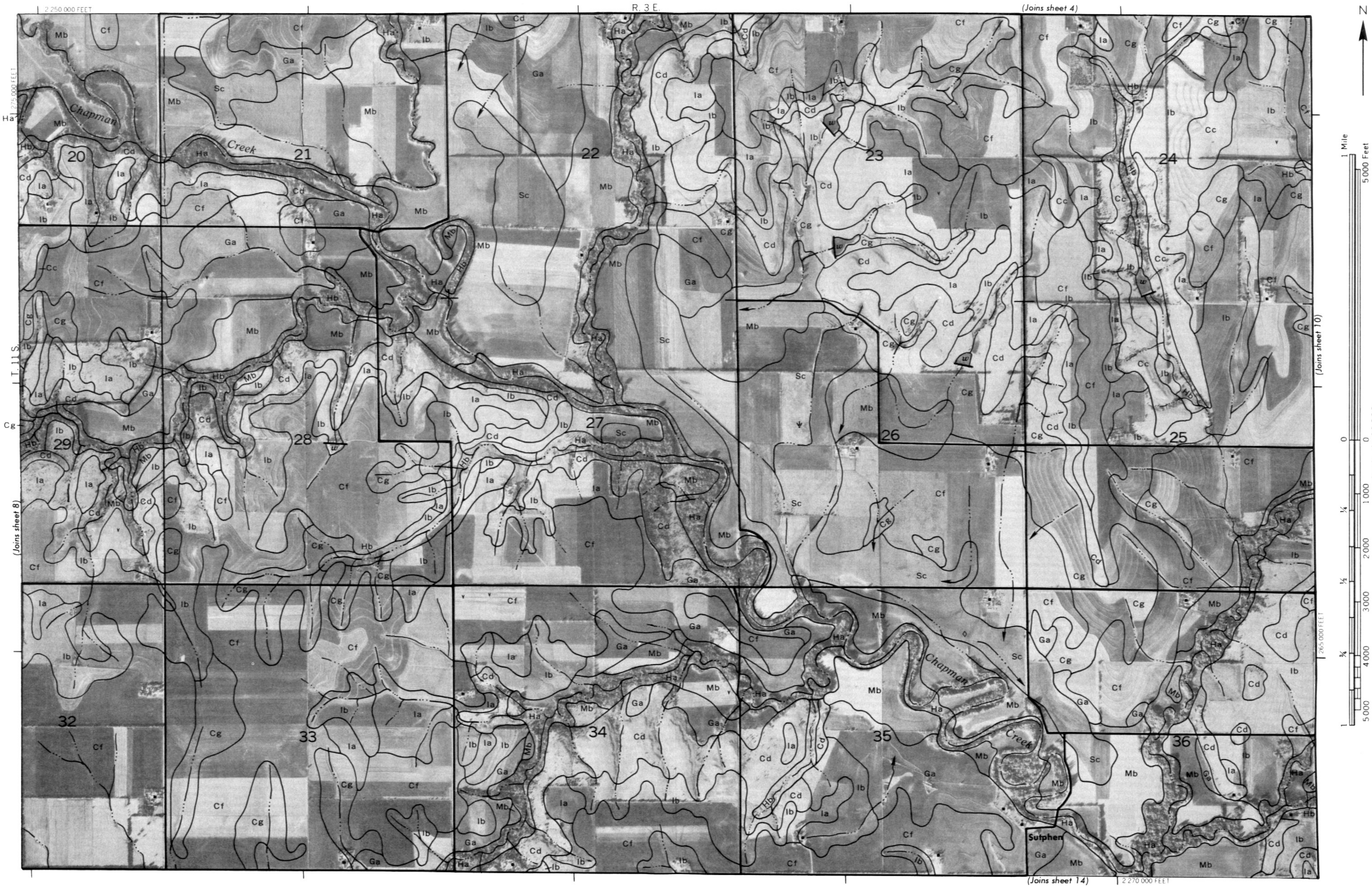
35
36
Mud Creek
PRAIRIEDALE CEMETERY
1 Mile
5000 Feet
Scale 1:20000

DICKINSON COUNTY, KANSAS — SHEET NUMBER 8




2 250 000 FEET
R. 3 E.
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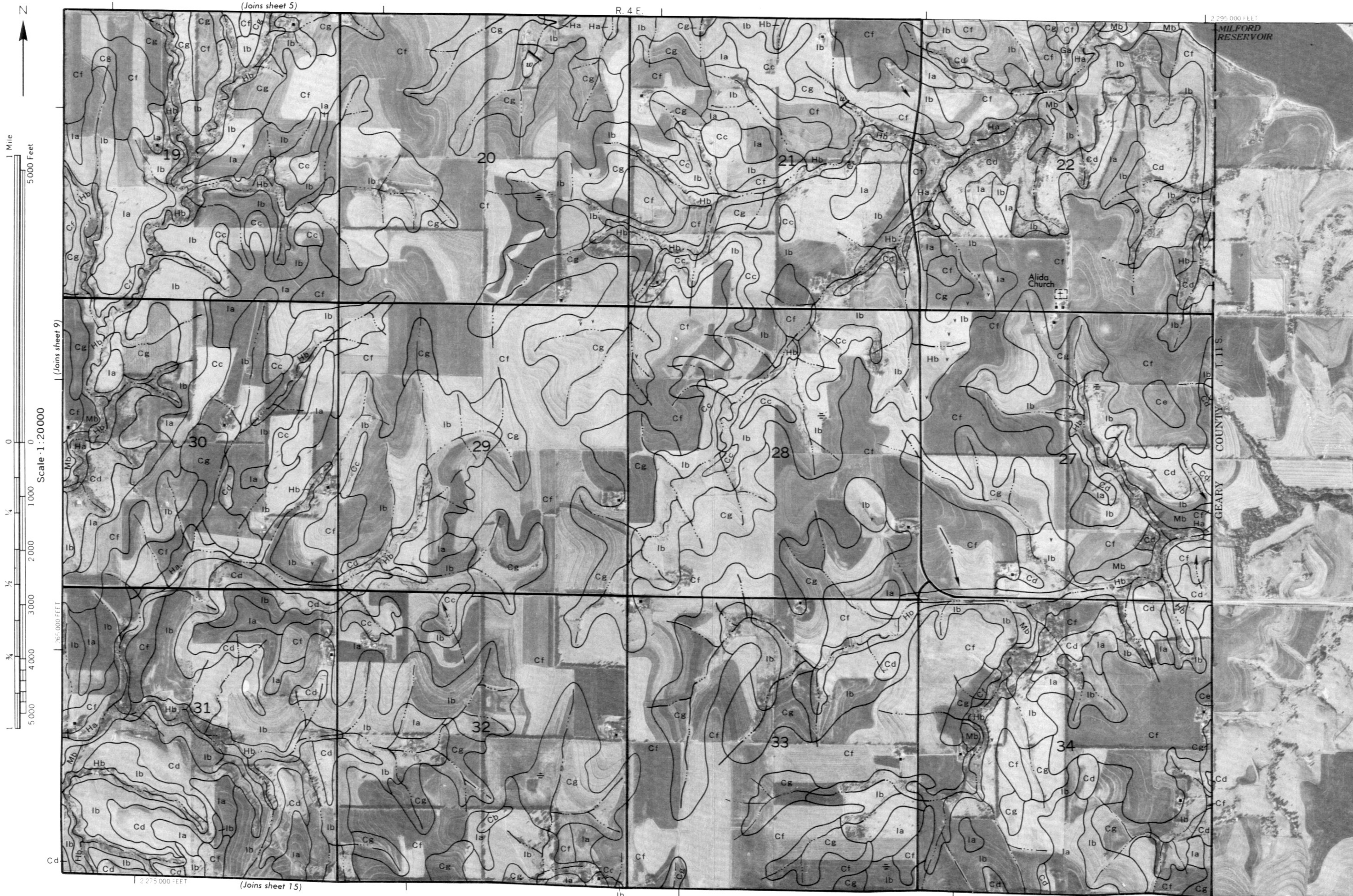
N
275 000 FEET
T. 11 S.
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 14)
2 270 000 FEET
265 000 FEET
Chapman
Creek
Chapman
Creek
Sutphen
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 Mile
5000 Feet
Scale 1:20000
0
1/4
1/2
3/4
1
0
1000
2000
3000
4000
5000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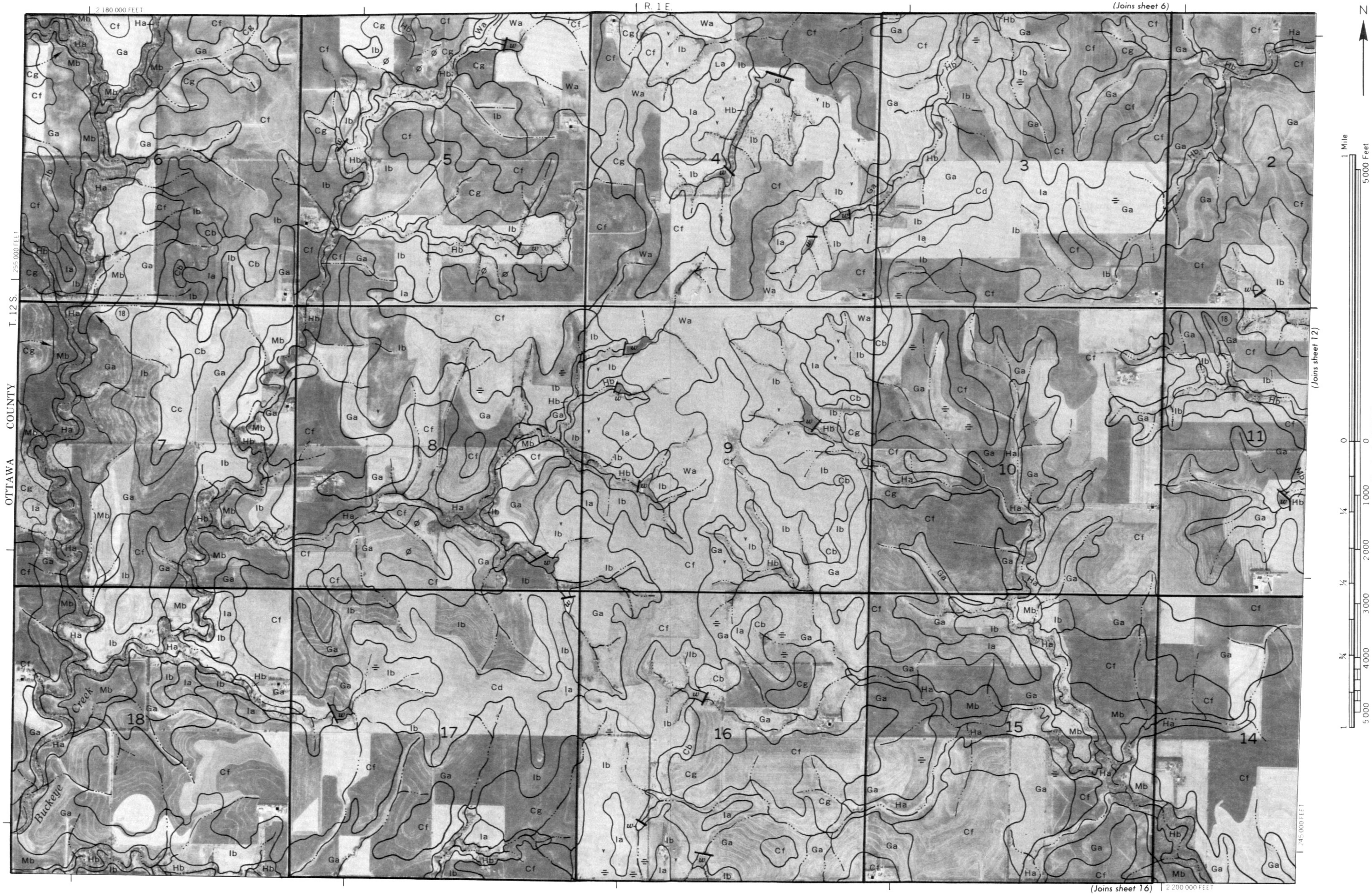
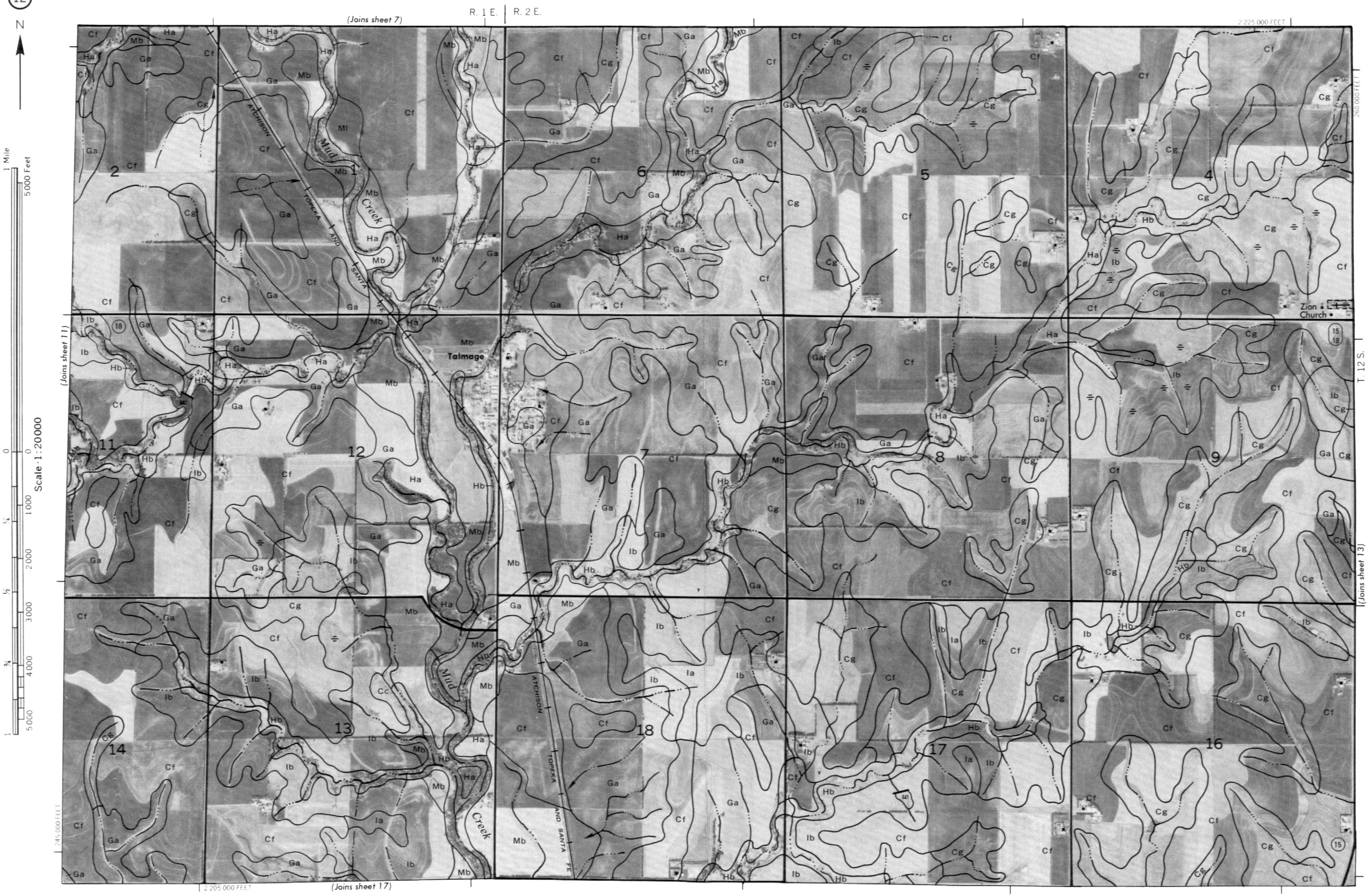
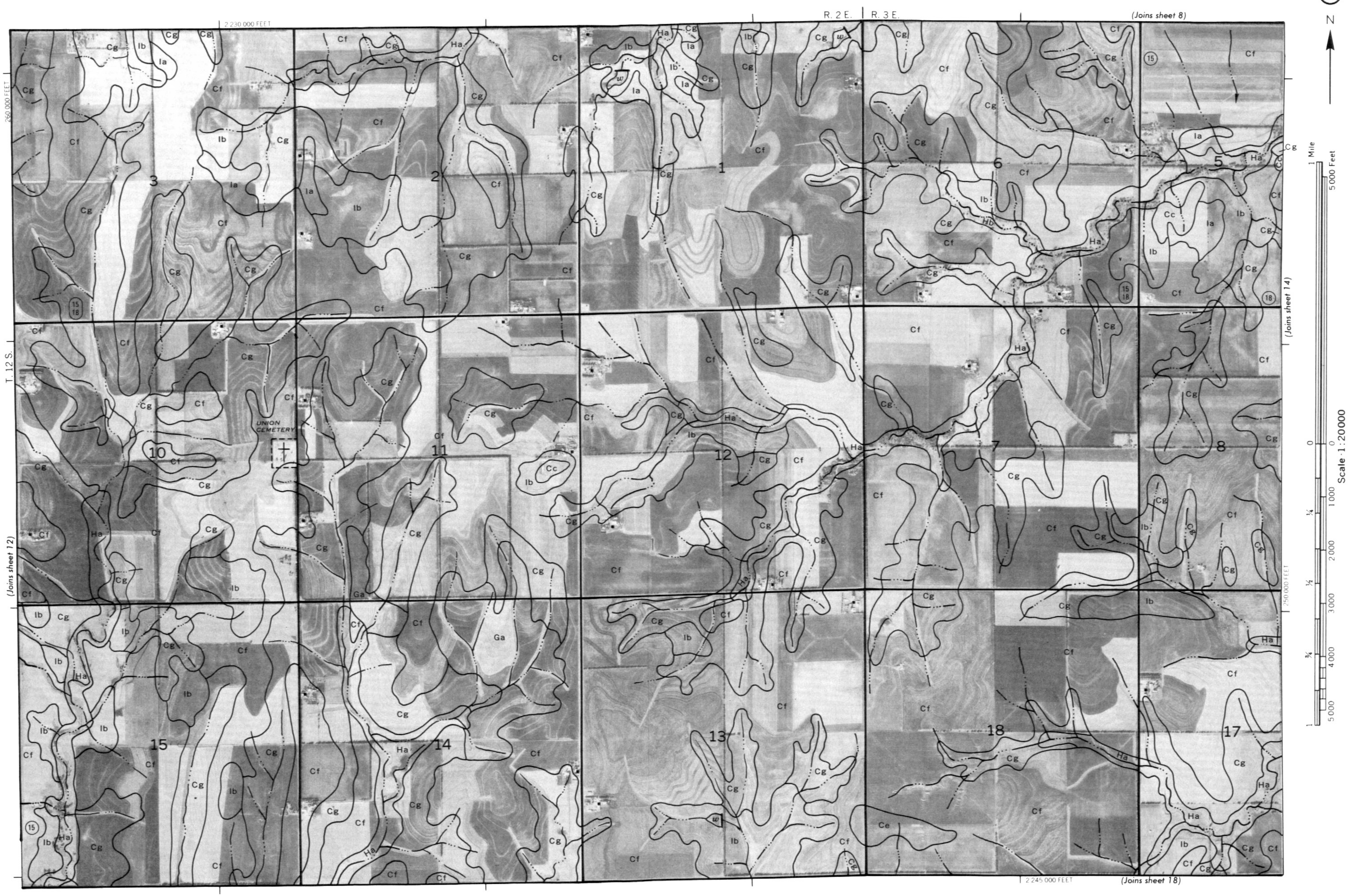
R. 4 E.
2 295 000 FEET
MILFORD RESERVOIR
275 000 FEET
(Joins sheet 9)
1 Mile
5000 Feet
Scale 1:20000
265 000 FEET
Alida Church
GEARY COUNTY
T. 11 S.
19
20
21
22
30
29
28
27
31
32
33
34
2 275 000 FEET
(Joins sheet 15)


2 180 000 FEET
R. 1 E.
(Joins sheet 6)
N
T. 12 S.
255 000 FEET
OTTAWA COUNTY
(Joins sheet 12)
Buckeye Creek
245 000 FEET
(Joins sheet 16)
2 200 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1

12

DICKINSON COUNTY, KANSAS — SHEET NUMBER 12




13
N
R. 2 E.
R. 3 E.
(Joins sheet 8)
(Joins sheet 14)
(Joins sheet 18)
(Joins sheet 12)
T. 12 S.
2 230 000 FEET
260 000 FEET
250 000 FEET
2 245 000 FEET
UNION CEMETERY
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
0
1
1
2
3
4
5
6
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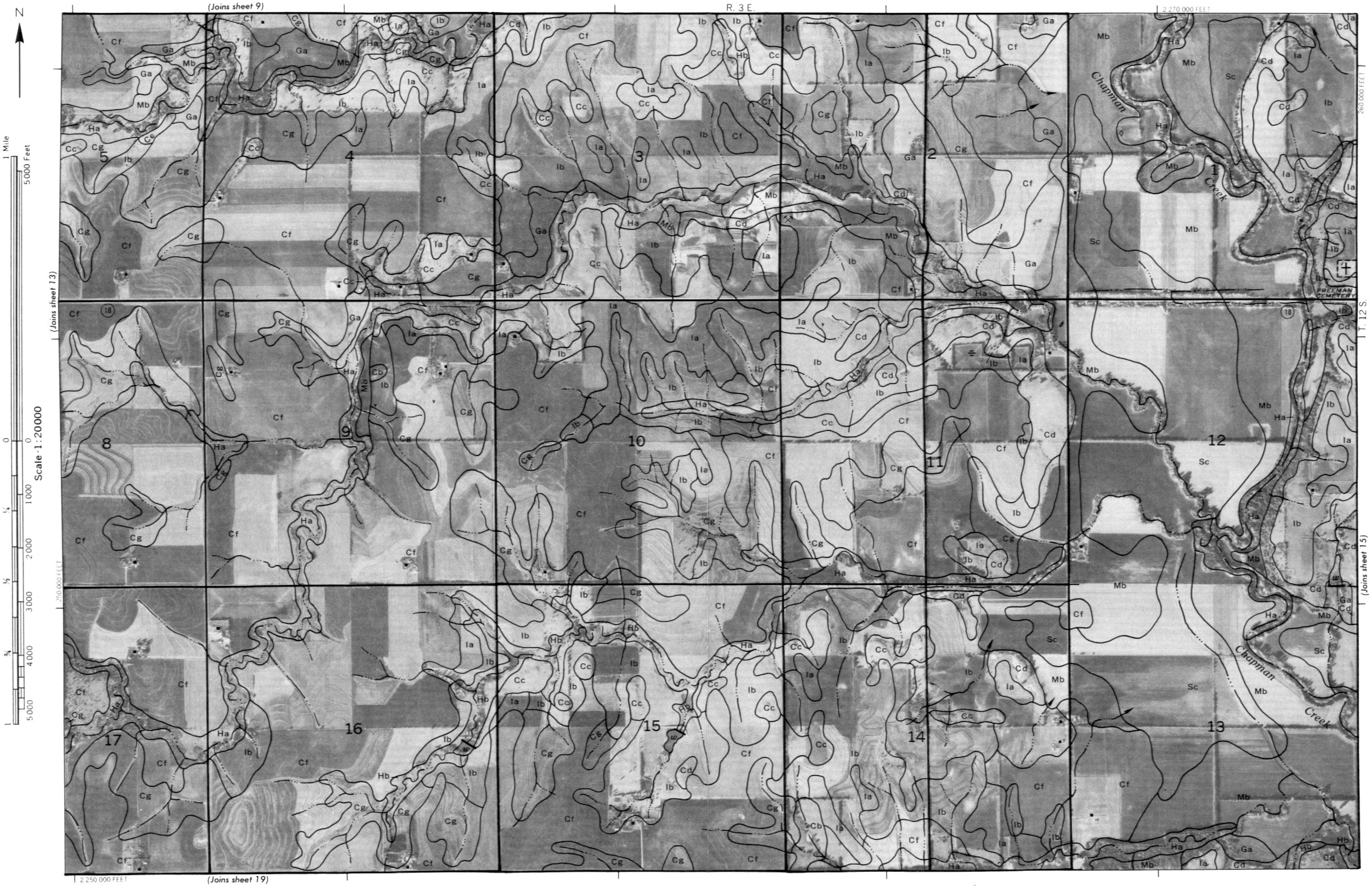
8
10
11
12
13
14
15
17
18


N
(Joins sheet 9)
R. 3 E.
2 270 000 FEET
260 000 FEET
(Joins sheet 13)
T. 12 S.
(Joins sheet 15)
250 000 FEET
2 250 000 FEET
(Joins sheet 19)
Chapman
Creek
FREEMAN CEMETERY
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

N
(Joins sheet 10)
(Joins sheet 14)
(Joins sheet 20)
R. 4 E.
T. 12 S.
2 275 000 FEET
250 000 FEET
2 295 000 FEET
GOOD HOPE CEMETERY
GEARY COUNTY
Chapman Creek
1 Mile
5 000 Feet
Scale 1:20000
6
5
4
3
7
8
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10
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17
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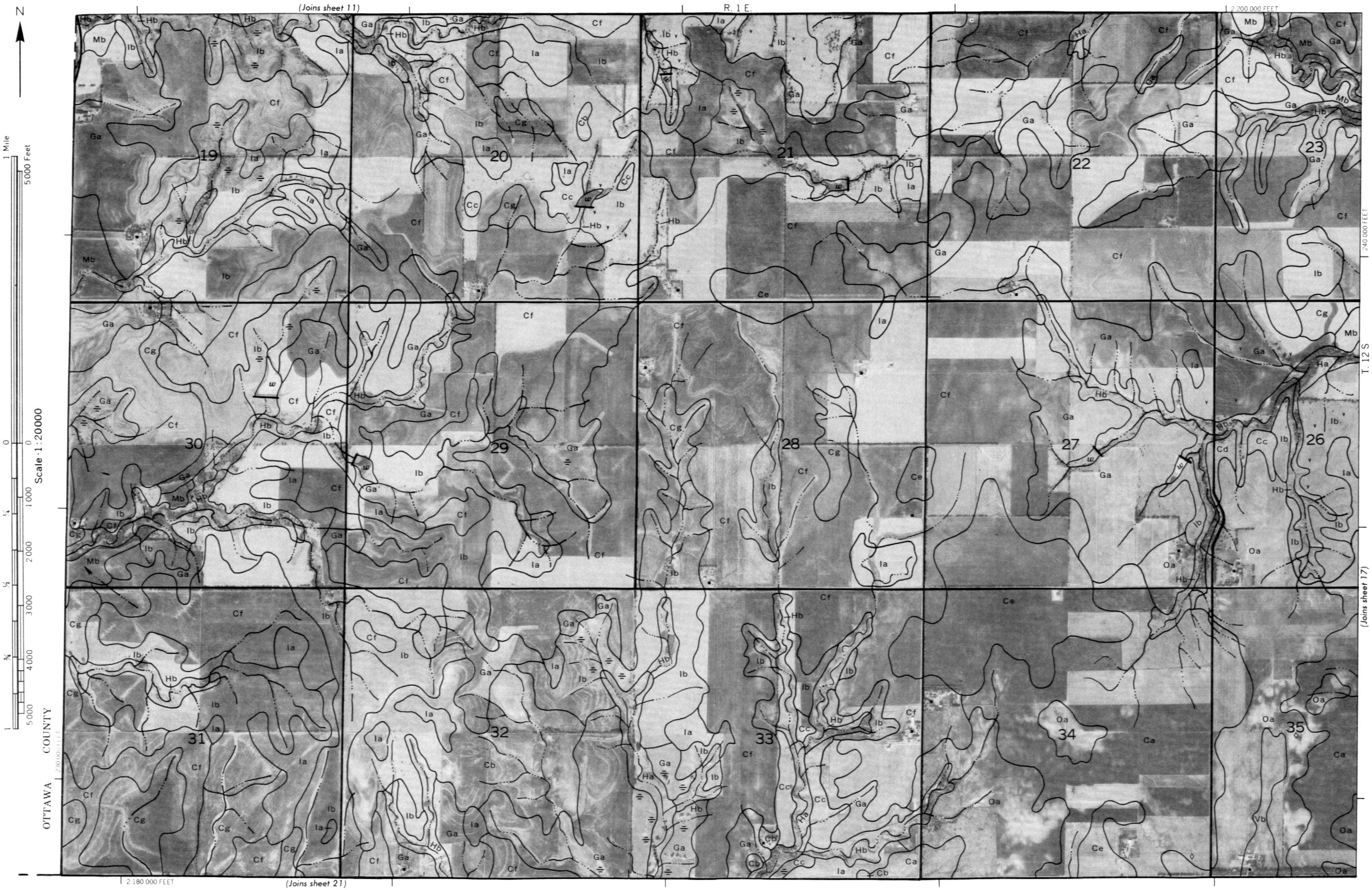
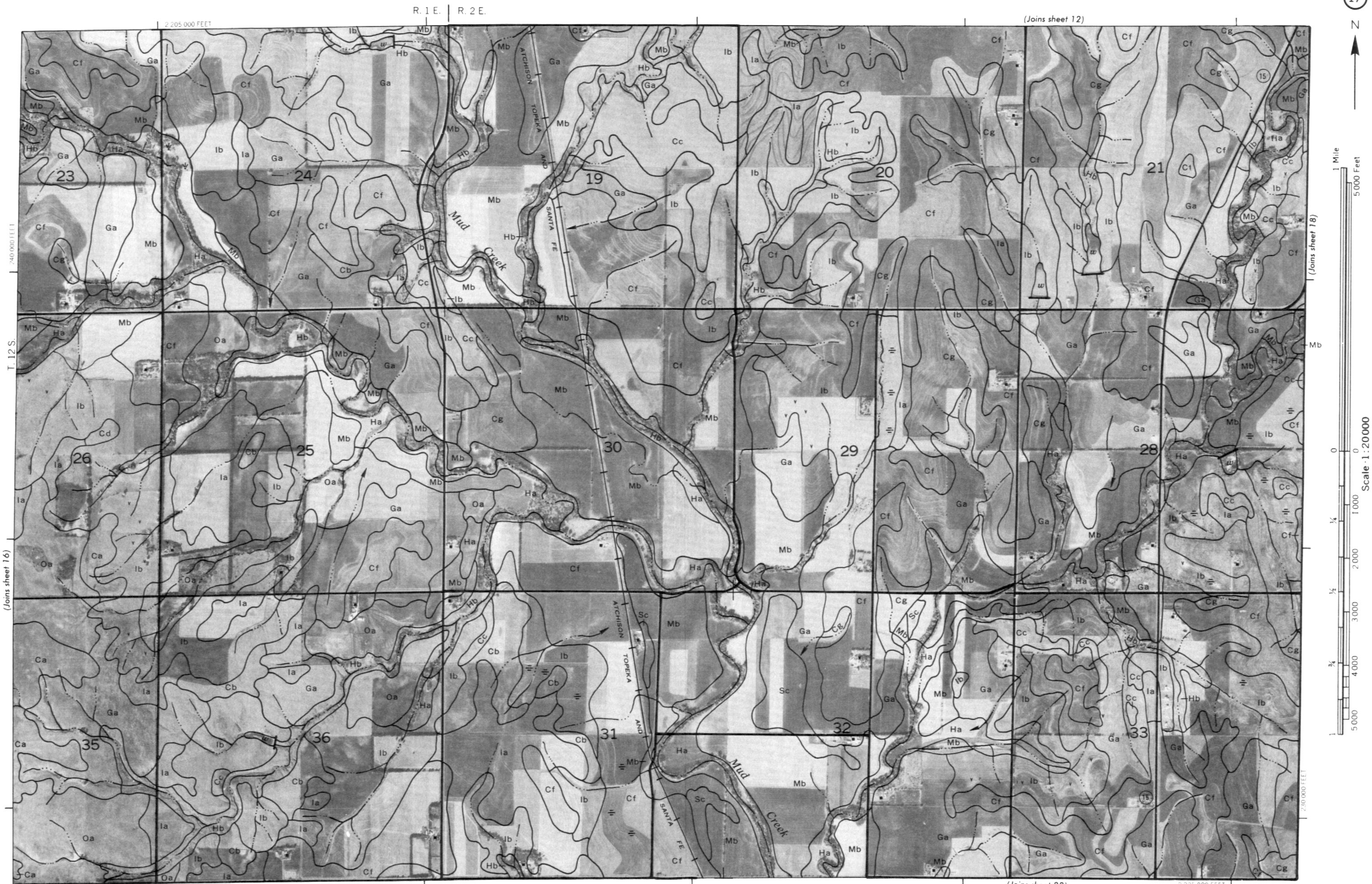
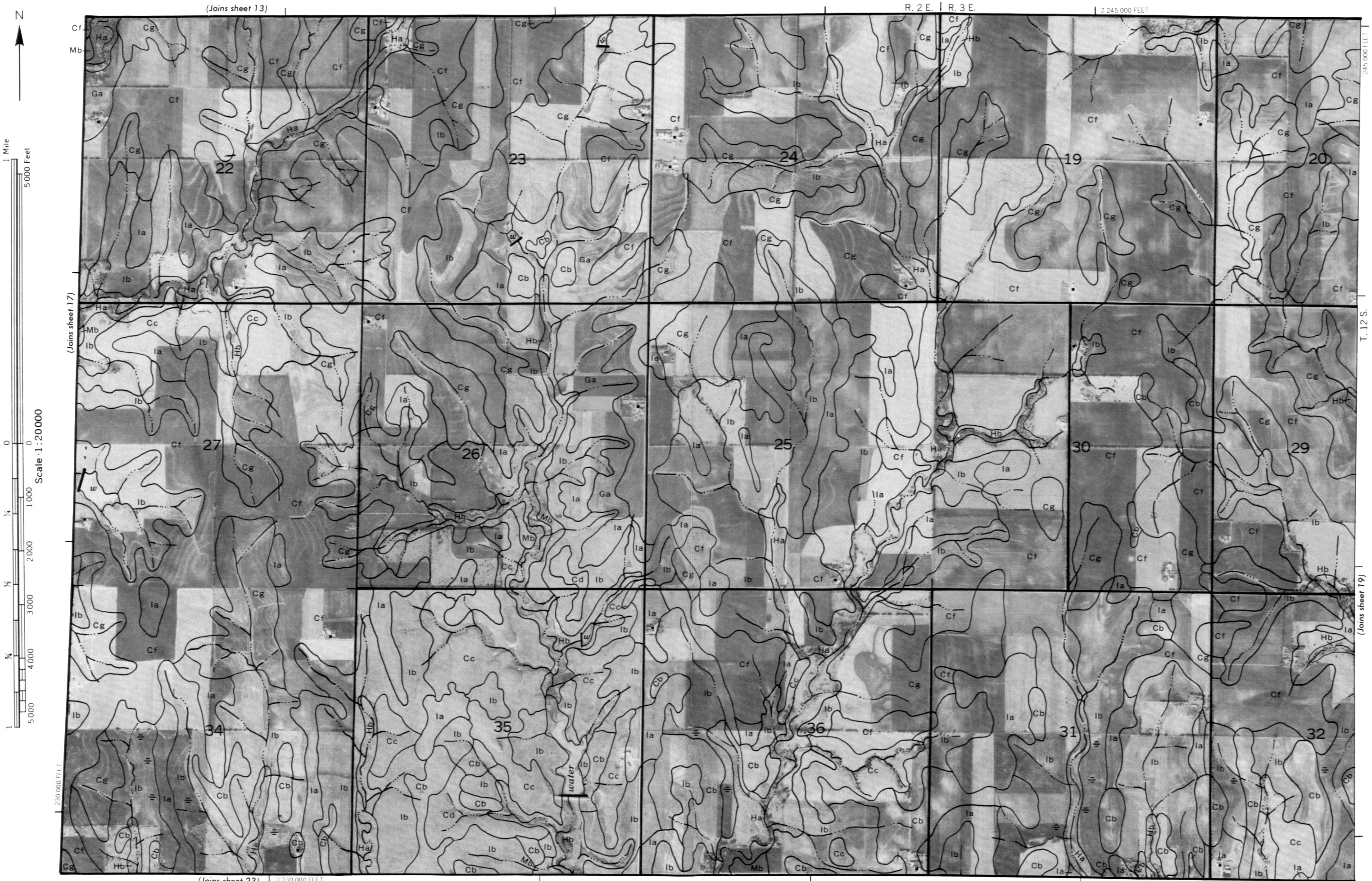
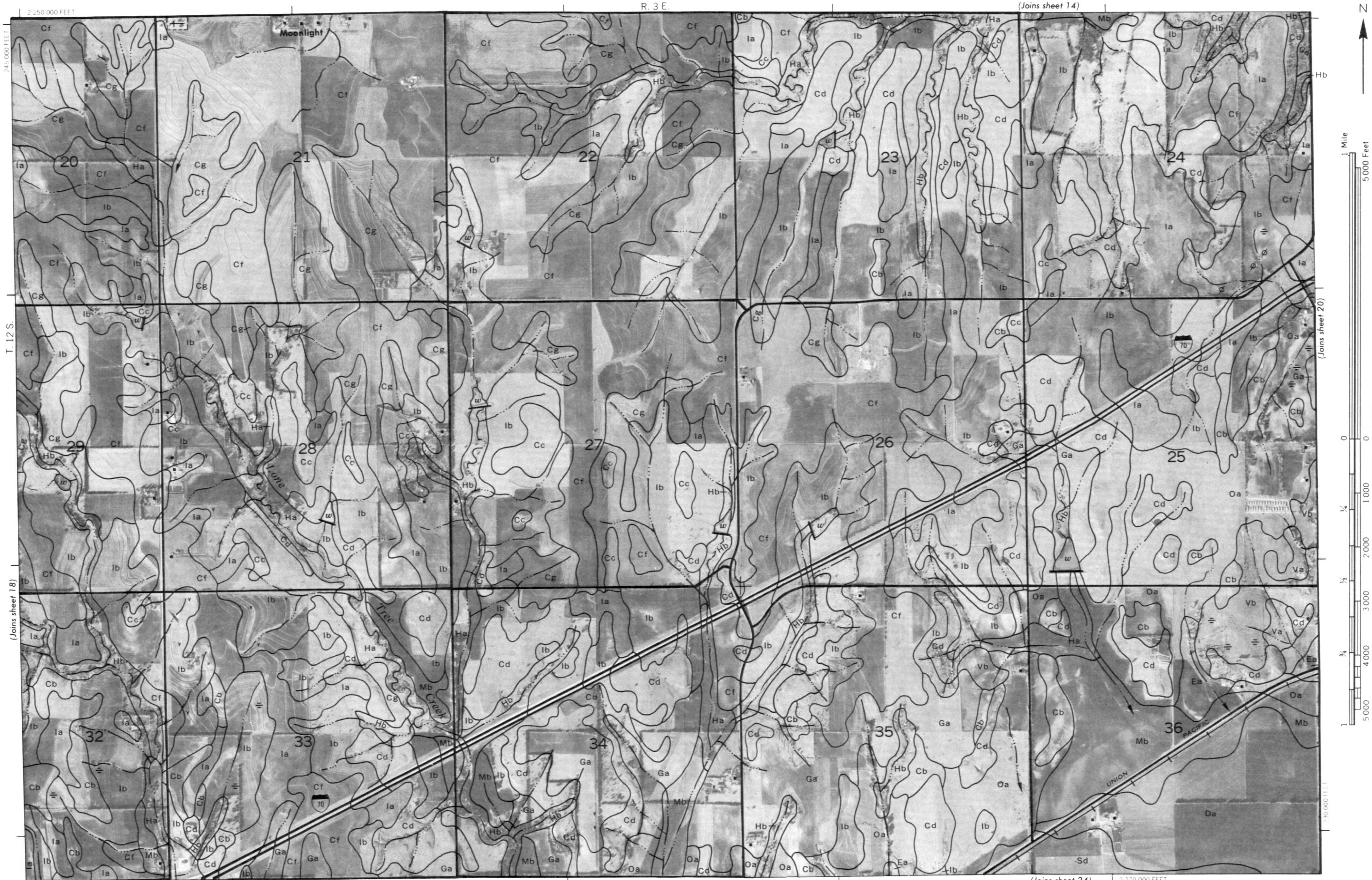
15

DICKINSON COUNTY, KANSAS — SHEET NUMBER 16

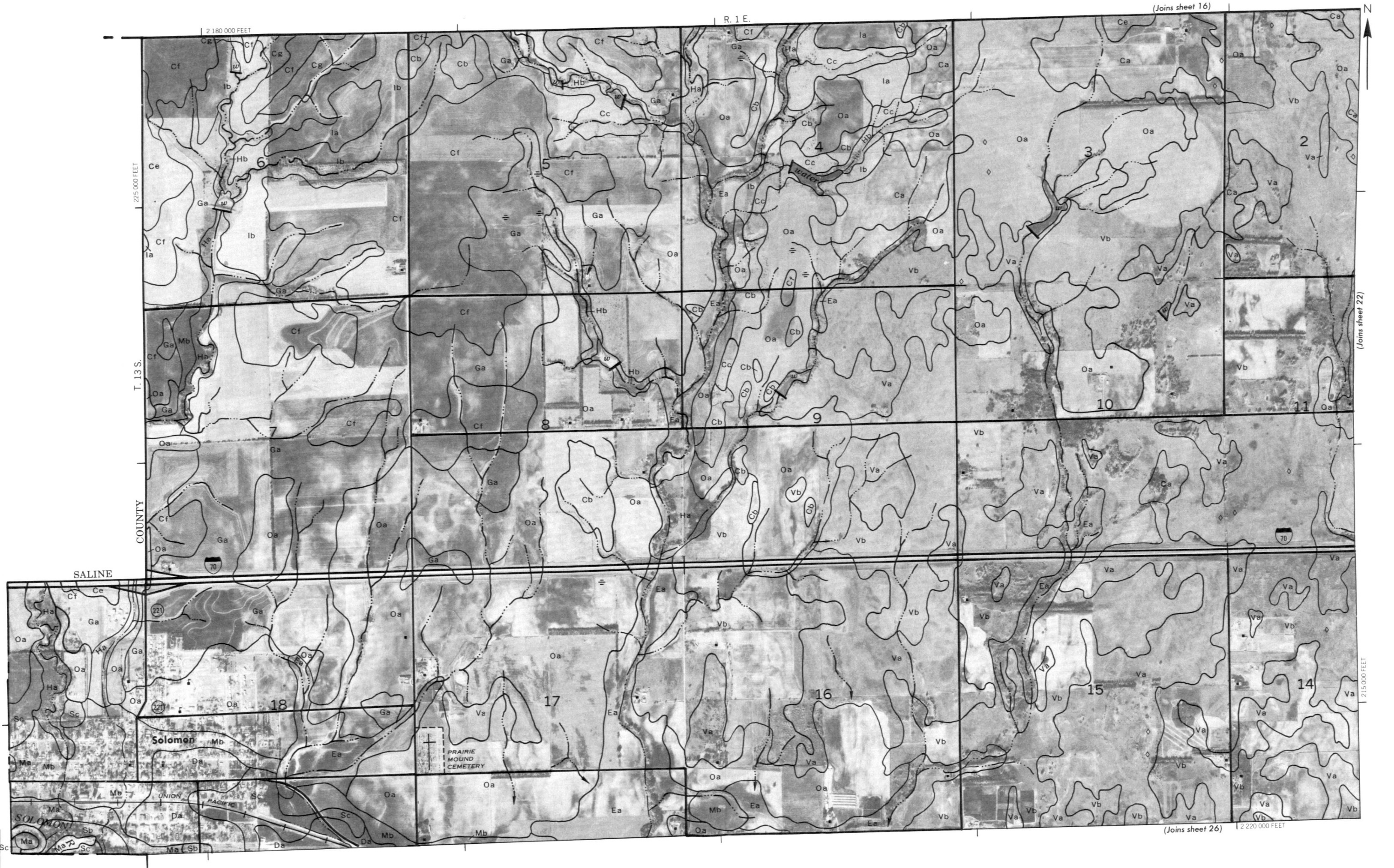


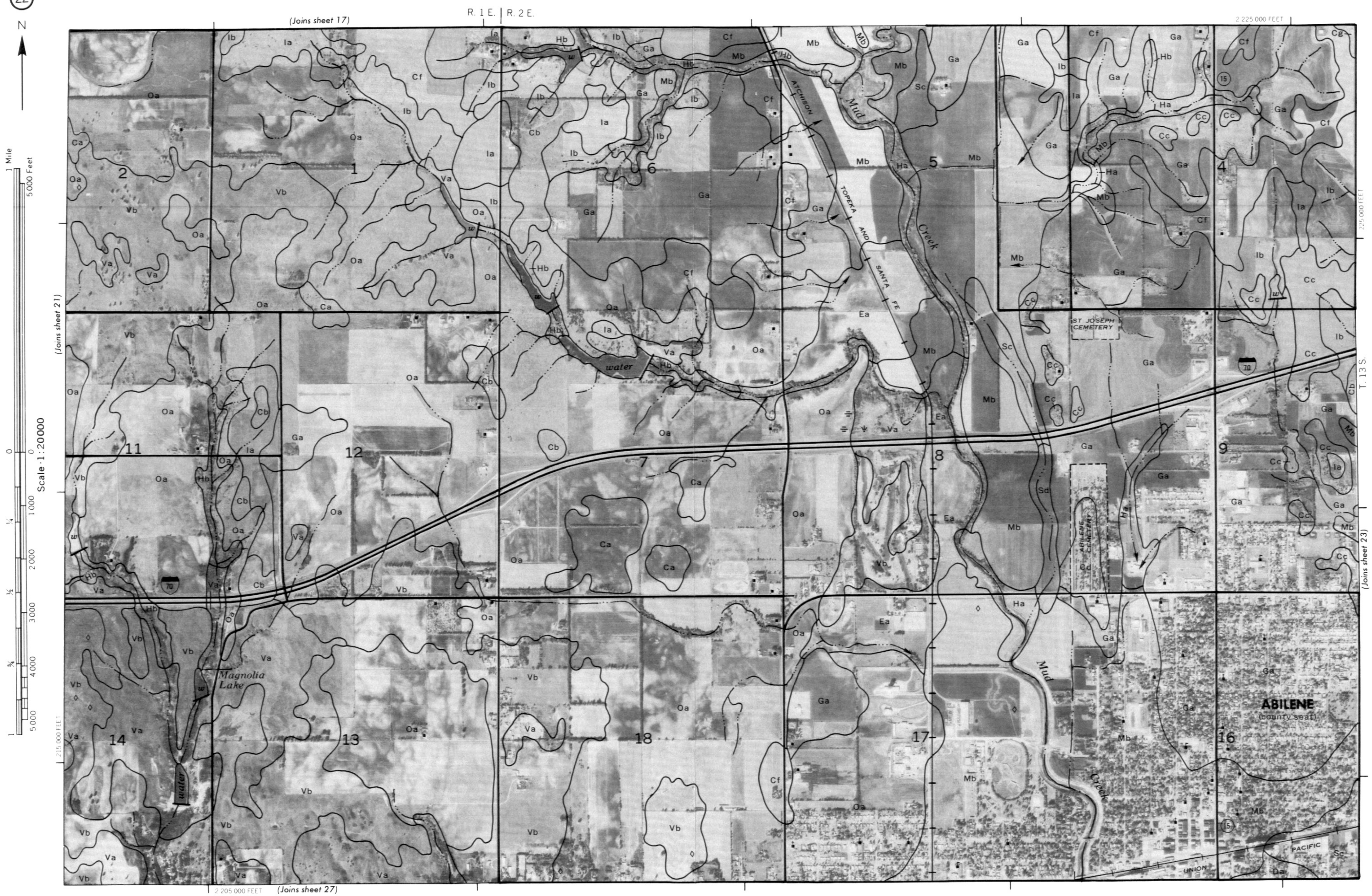

17
R. 1 E.
R. 2 E.
T. 12 S.
2 205 000 FEET
240 000 FEET
2 225 000 FEET
230 000 FEET
(Joins sheet 12)
(Joins sheet 18)
(Joins sheet 22)
(Joins sheet 16)
Mud Creek
ATCHISON TOPEKA AND SANTA FE
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
N
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000

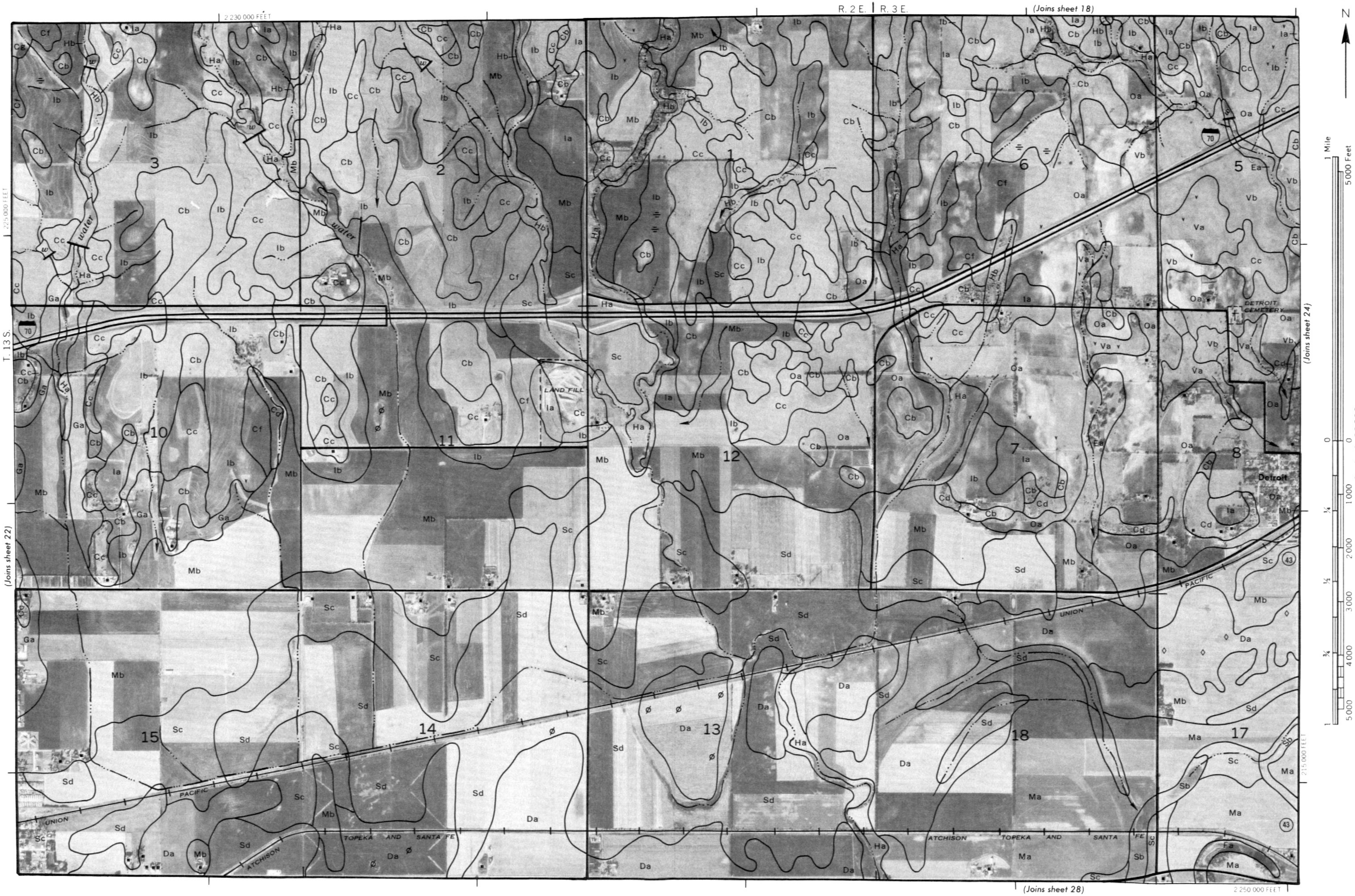

N
(Joins sheet 13)
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 23)
R. 2 E. | R. 3 E.
T. 12 S.
2 245 000 FEET
245 000 FEET
230 000 FEET
2 230 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
water
Cf
Cg
Ha
Hb
Ia
Ib
Ga
Cb
Cc
Cd
Mb


19
N
R. 3 E.
T. 12 S.
2 250 000 FEET
245 000 FEET
2 270 000 FEET
230 000 FEET
(Joins sheet 14)
(Joins sheet 20)
(Joins sheet 18)
(Joins sheet 24)
Moonlight
Lone Tree Creek
UNION PACIFIC
70
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36
1 Mile
5000 Feet
Scale 1:20000

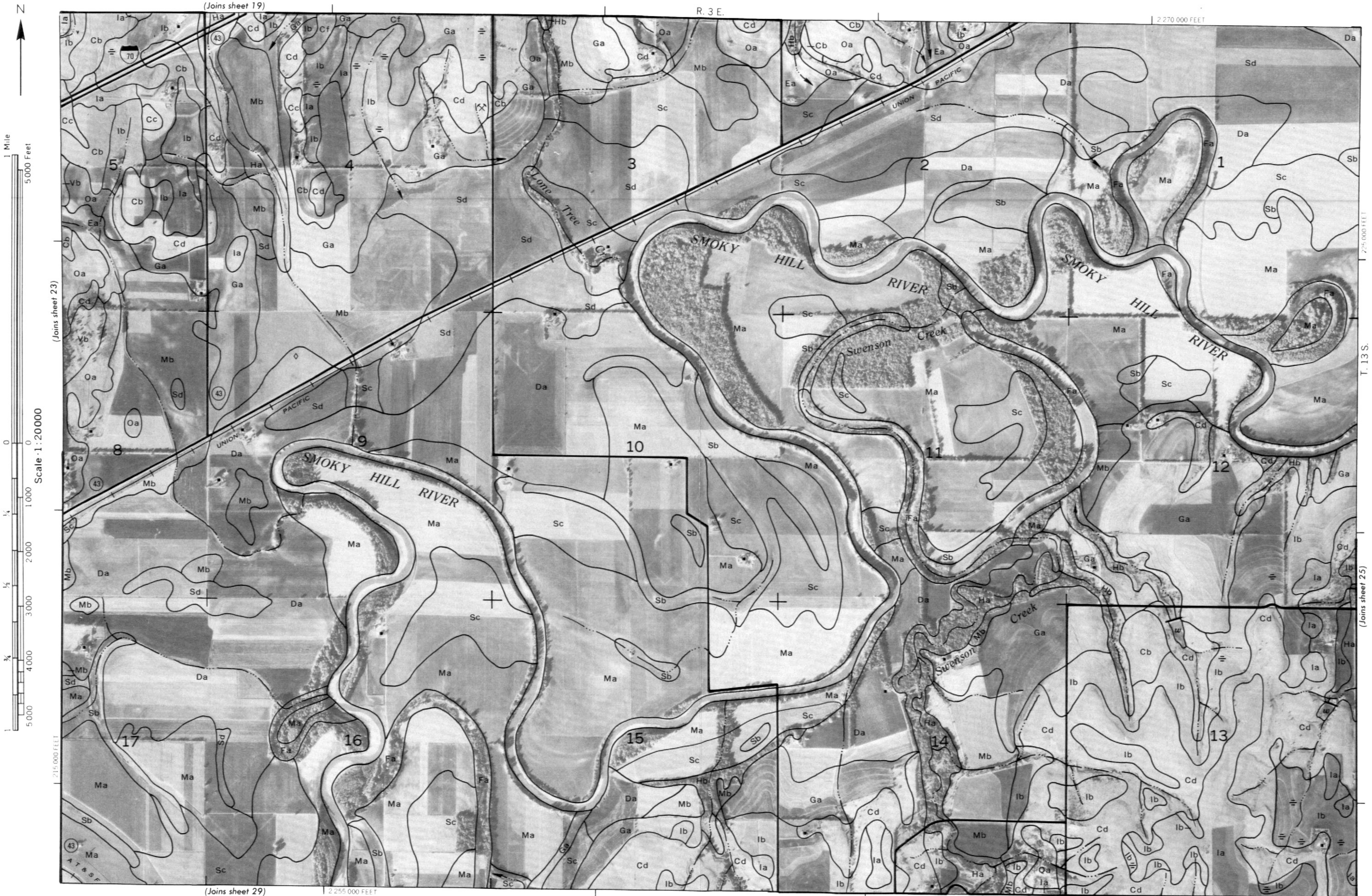

N
(Joins sheet 15)
R. 4 E.
2 295 000 FEET
245 000 FEET
(Joins sheet 19)
(Joins inset, sheet 43)
T. 12 S.
(Joins sheet 25)
2 275 000 FEET
230 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
0
¼
½
¾
1
Chapman Creek
Chapman
Creek
St Patrick Church
INDIAN HILL CEMETERY
Chapman
UNION PACIFIC
SMOKY HILL RIVER
SMOKY HILL RIVER
GEARY COUNTY
GEARY COUNTY
70
206
19
20
21
22
27
28
29
30
31
32
33
34
35


N
(Joins sheet 16)
R. 1 E.
2 180 000 FEET
225 000 FEET
T. 13 S.
SALINE
COUNTY
(Joins sheet 22)
215 000 FEET
(Joins sheet 26)
2 220 000 FEET
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18
Solomon
PRAIRIE
MOUND
CEMETERY
UNION
PACIFIC
SOLOMON
R.
water
70
221

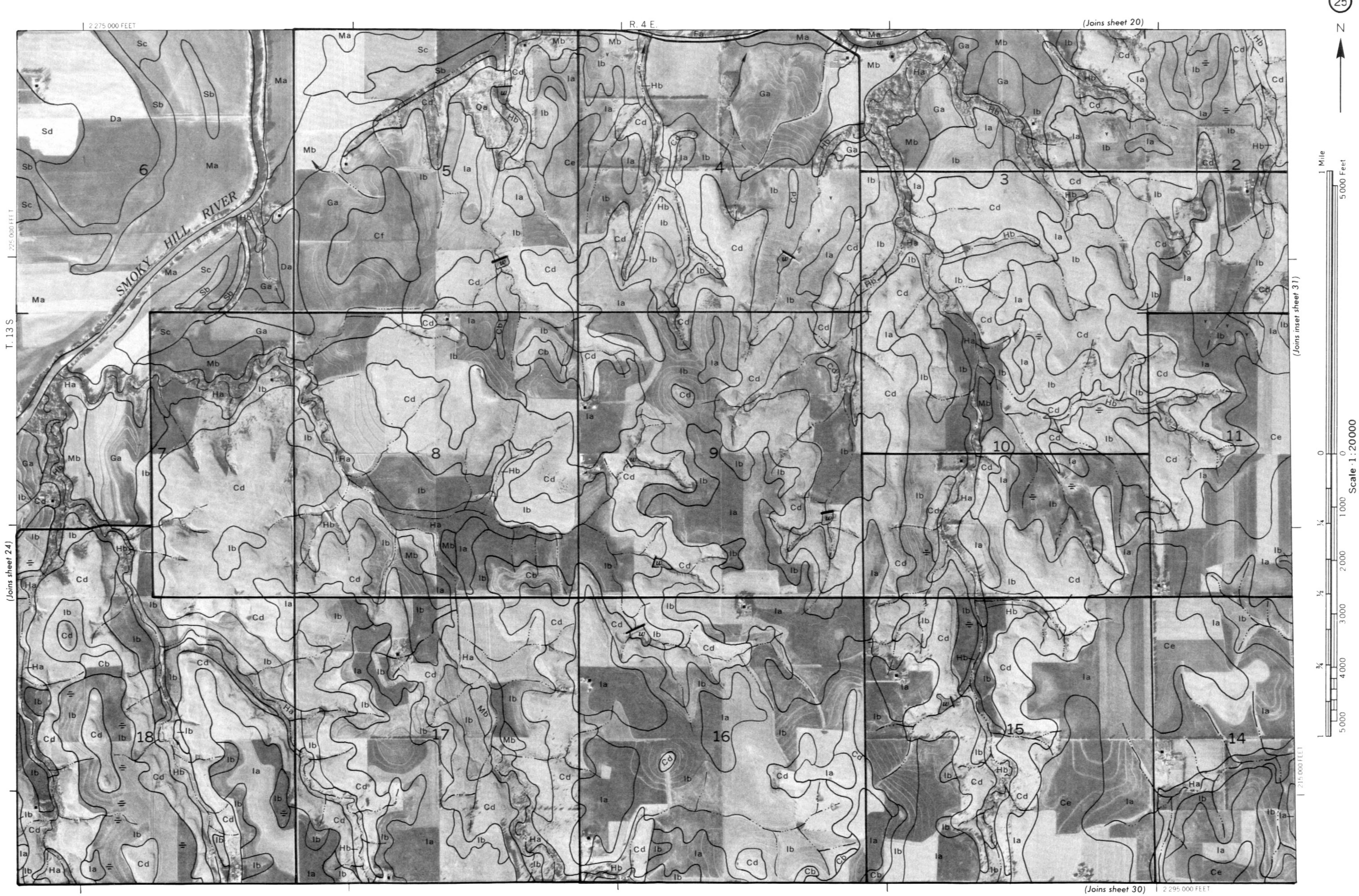

22
N
(Joins sheet 17)
R. 1 E.
R. 2 E.
2 225 000 FEET
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 27)
2 205 000 FEET
215 000 FEET
225 000 FEET
T. 13 S.
1 Mile
5000 Feet
Scale 1:20000
ATCHISON TOPEKA AND SANTA FE
Mud Creek
water
Magnolia Lake
ST JOSEPH CEMETERY
ABILENE CEMETERY
ABILENE
(county seat)
UNION PACIFIC
70
15
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

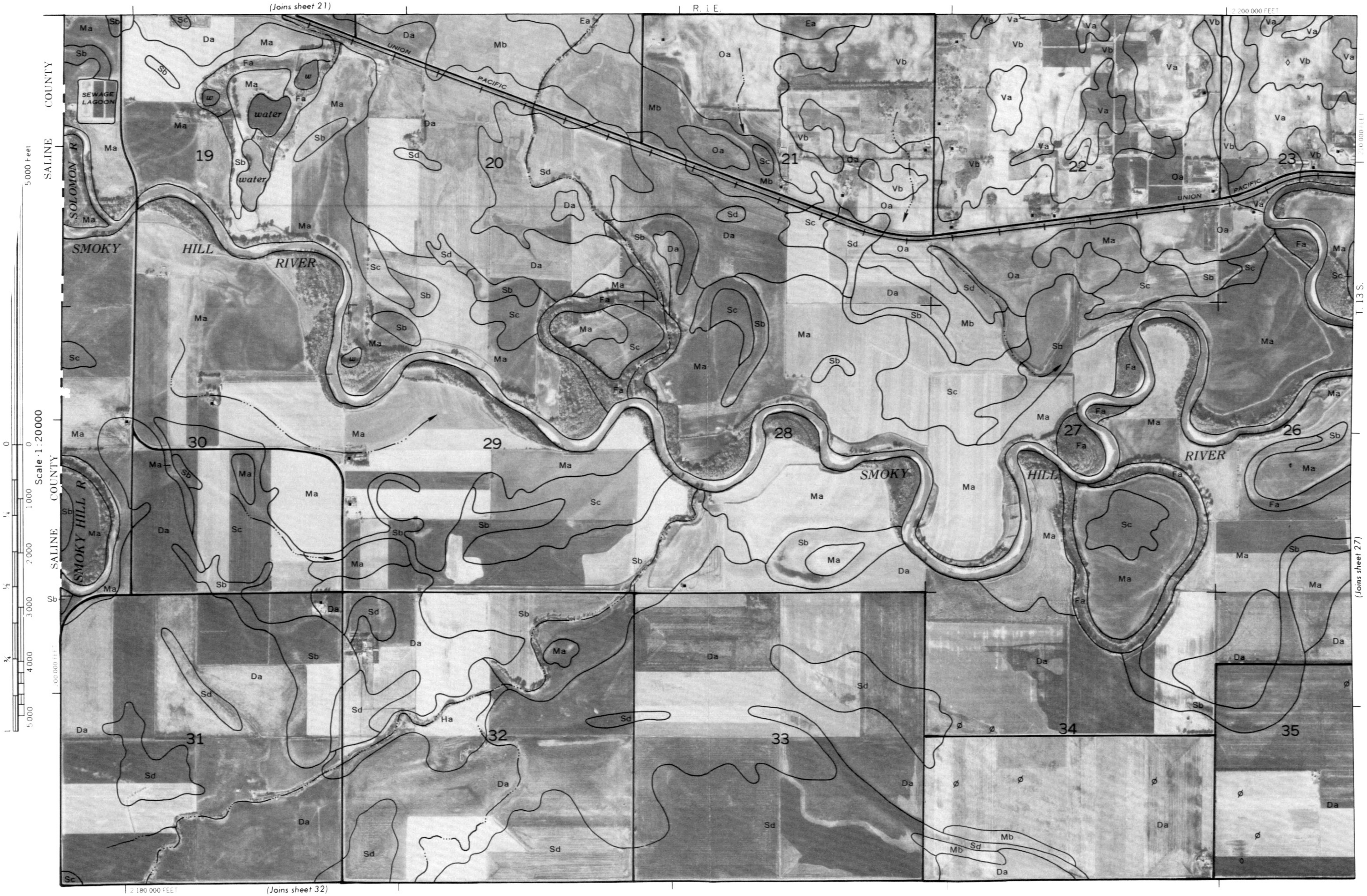


(Joins sheet 18)
R. 2 E.
R. 3 E.
(Joins sheet 24)
(Joins sheet 22)
(Joins sheet 28)
T. 13 S.
N
1 Mile
5000 Feet
Scale 1:20000
DETROIT CEMETERY
Detroit
LAND FILL
UNION PACIFIC
ATCHISON TOPEKA AND SANTA FE

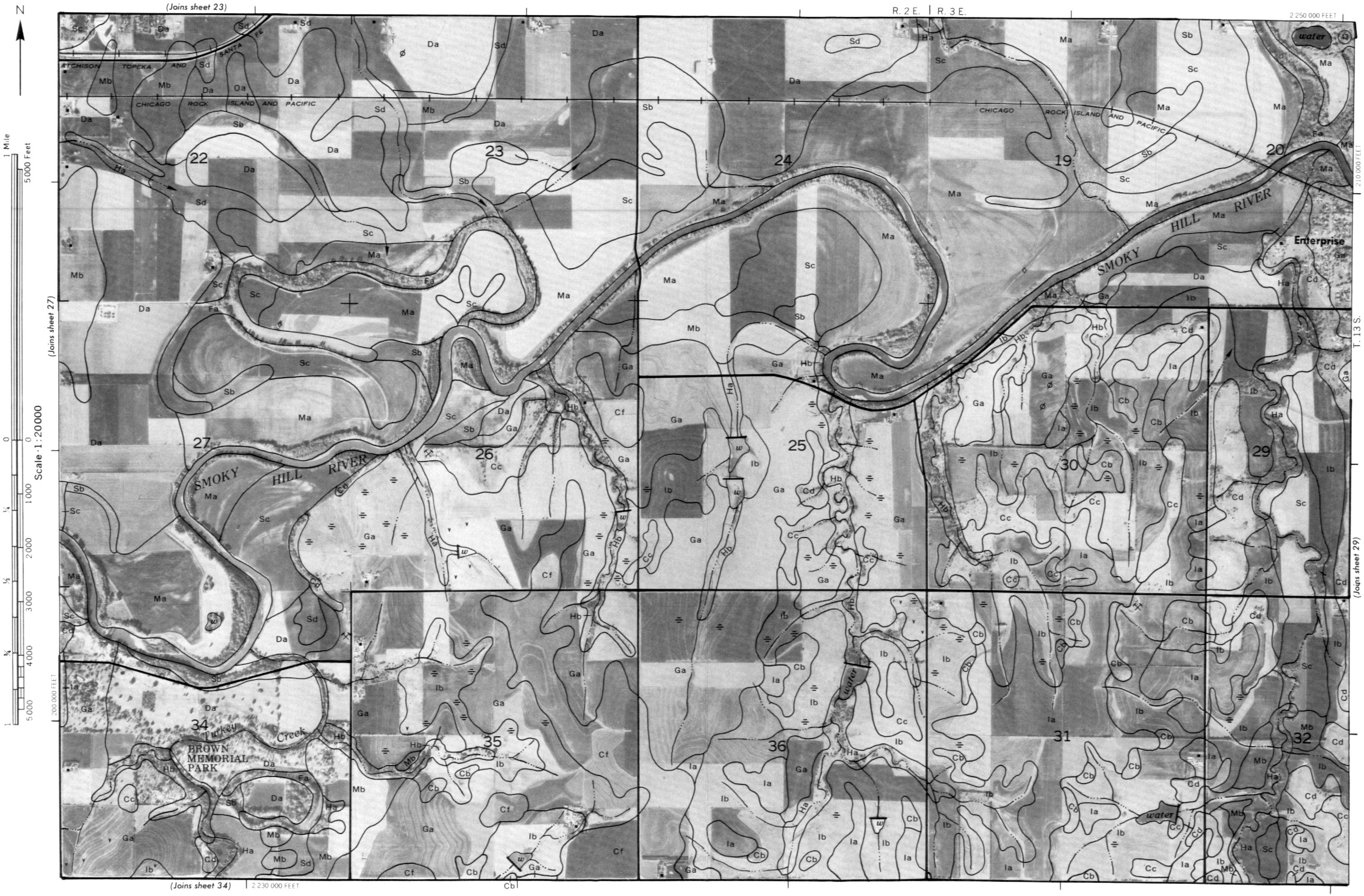

(Joins sheet 19)
R. 3 E.
2 270 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 29)
2 255 000 FEET
215 000 FEET
225 000 FEET
T. 13 S.
SMOKY HILL RIVER
Lone Tree Cr.
Swenson Creek
UNION PACIFIC
A T & S F
43
70
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

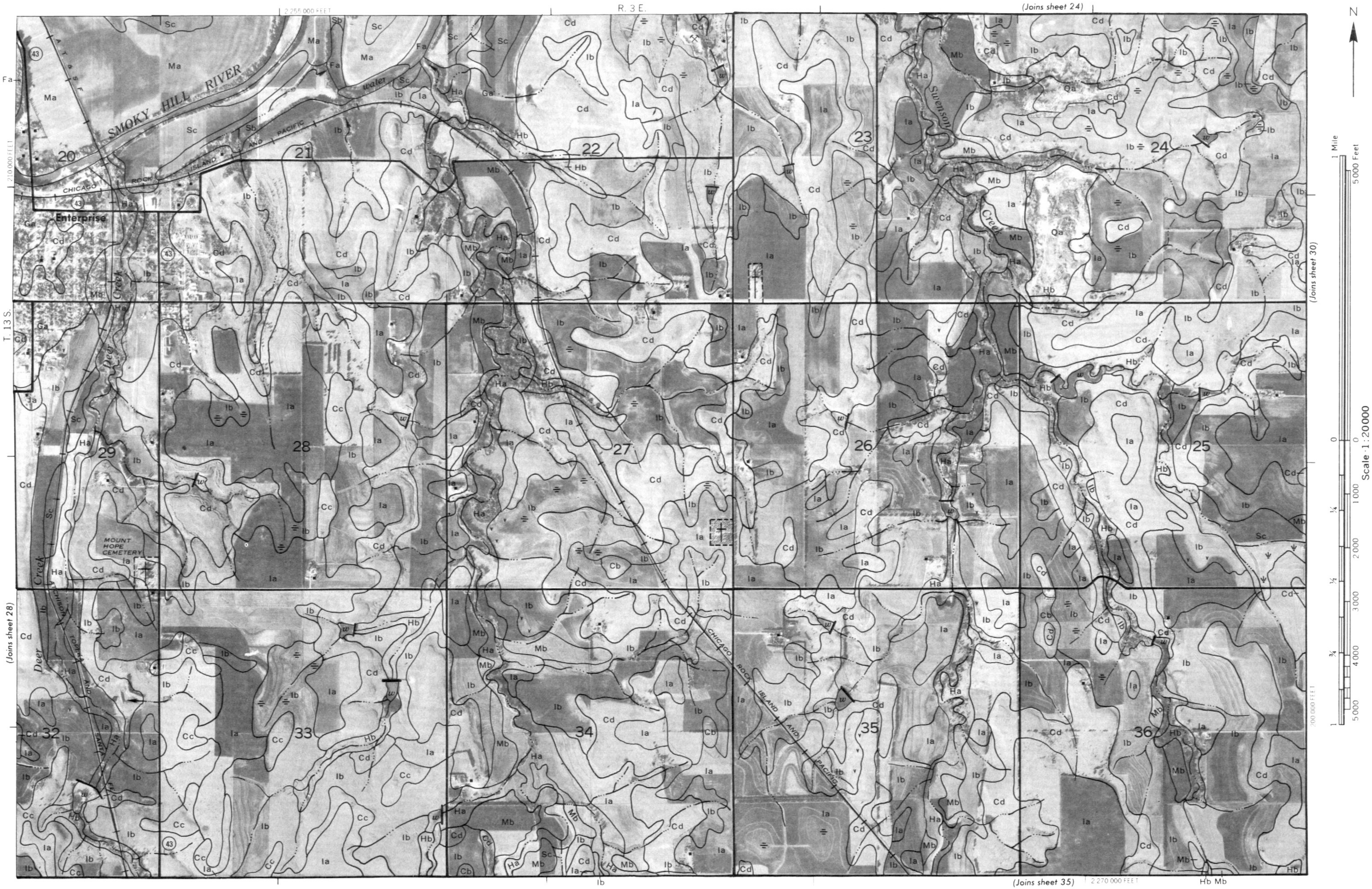
DICKINSON COUNTY, KANSAS — SHEET NUMBER 25

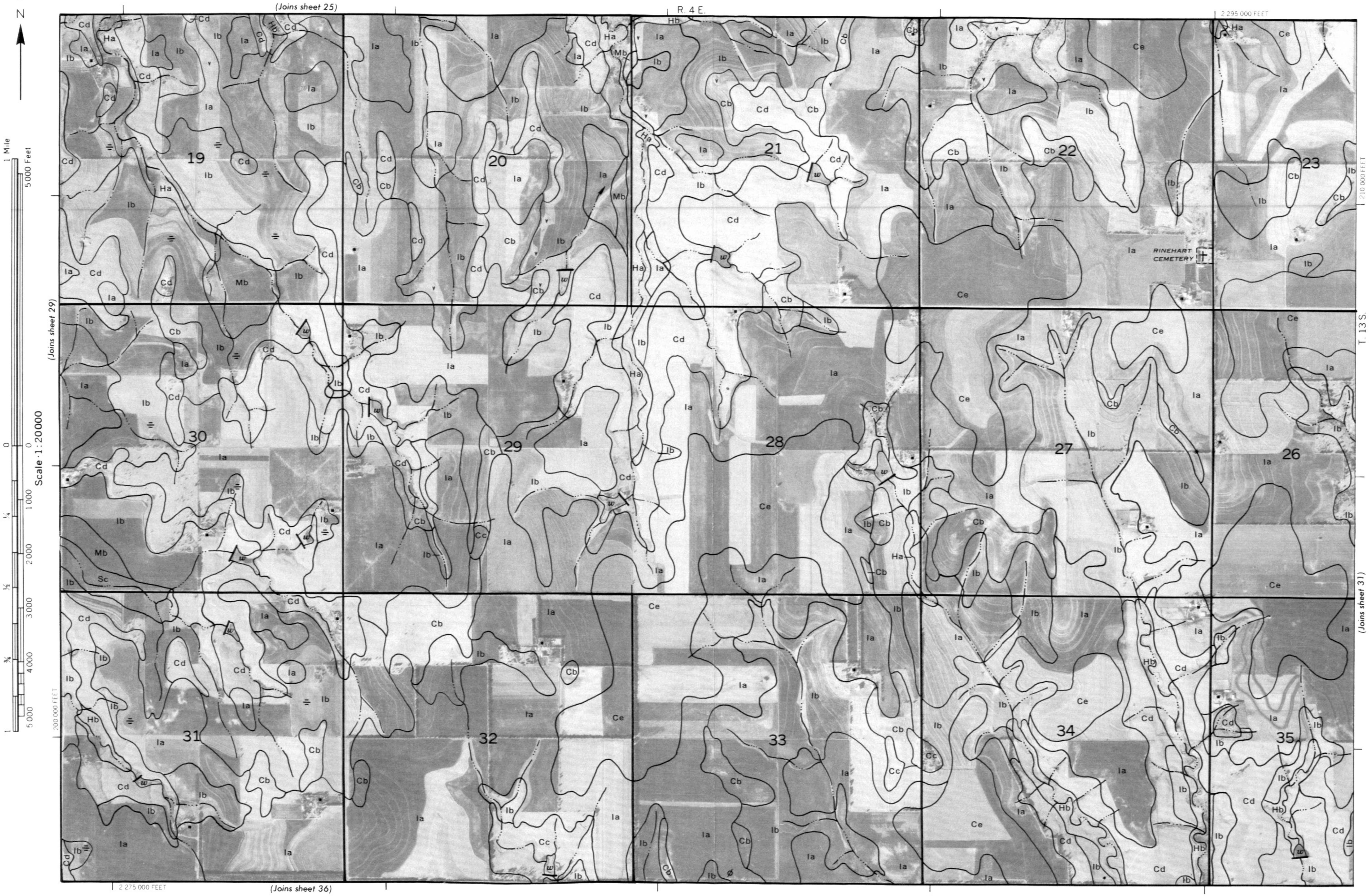



(Joins sheet 21)
R. 1 E.
2 200 000 FEET
UNION PACIFIC
SEWAGE LAGOON
water
SALINE COUNTY
SOLOMON R.
SMOKY HILL RIVER
SMOKY HILL R.
T. 13 S.
(Joins sheet 27)
(Joins sheet 32)
2 180 000 FEET
Scale 1:20000
5 000 Feet
0
1 000
2 000
3 000
4 000
5 000
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
Ma
Mb
Da
Sb
Sc
Sd
Fa
Ea
Oa
Va
Vb
Ha
w

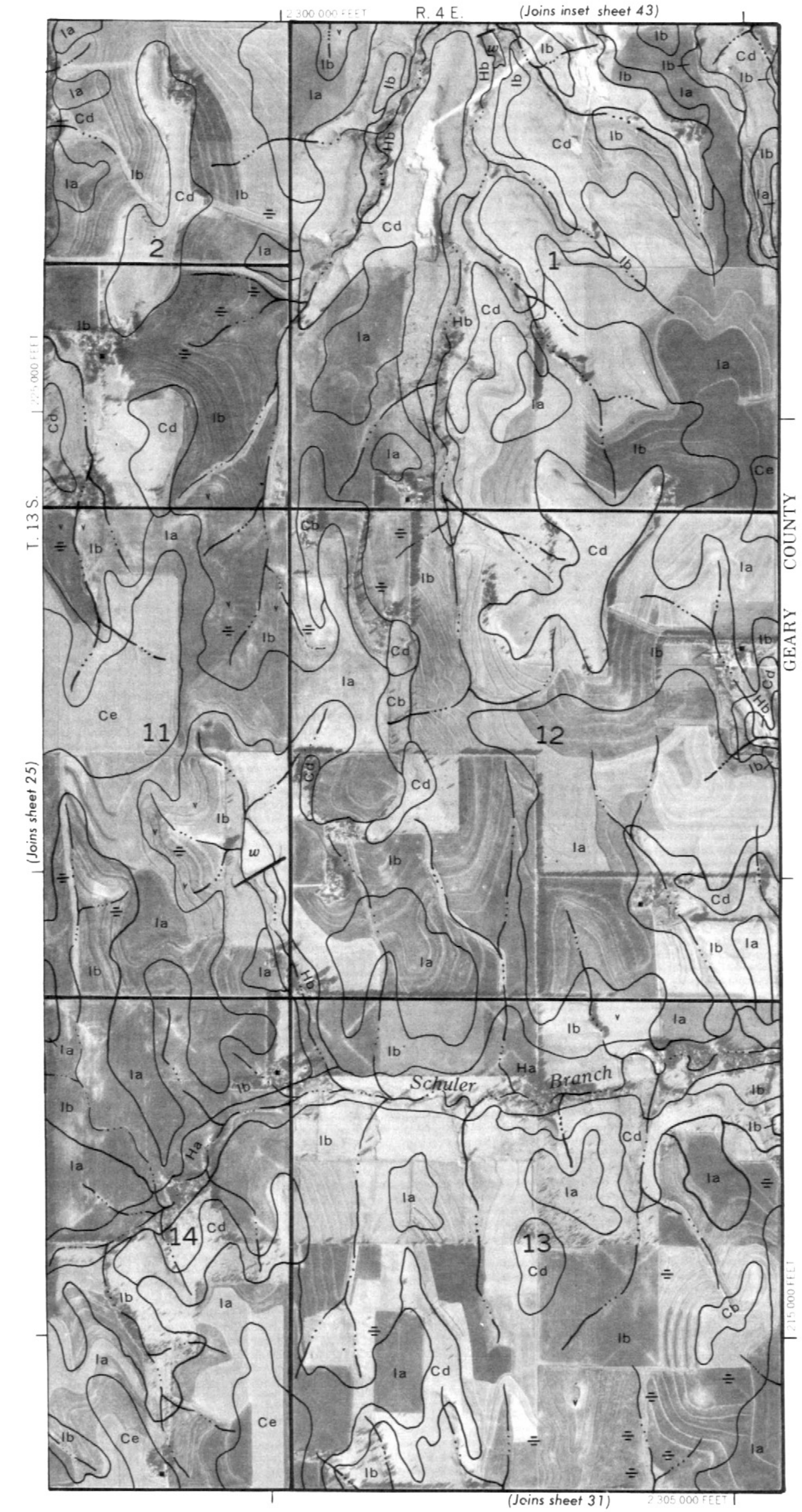

R. 1 E.
R. 2 E.
(Joins sheet 22)
ABILENE
(county seat)
ATCHISON TOPEKA AND SANTA FE
EISENHOWER CENTER
CHICAGO ROCK ISLAND AND PACIFIC
UNION PACIFIC
LAND FILL
Redbud Lake
Sand Spring
ABILENE AIRPORT
Landing Strip
SMOKY HILL RIVER
Mud Creek
Holland Creek
water
T. 13 S.
(Joins sheet 28)
(Joins sheet 26)
(Joins sheet 33)
2 205 000 FEET
2 225 000 FEET
210 000 FEET
200 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
23
24
19
20
21
25
26
30
29
28
36
35
31
32
33


N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 23)
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 34)
R. 2 E.
R. 3 E.
T. 13 S.
2 250 000 FEET
210 000 FEET
200 000 FEET
2 230 000 FEET
ATCHISON TOPEKA AND SANTA FE
CHICAGO ROCK ISLAND AND PACIFIC
SMOKY HILL RIVER
Enterprise
Turkey Creek
BROWN MEMORIAL PARK
water
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36

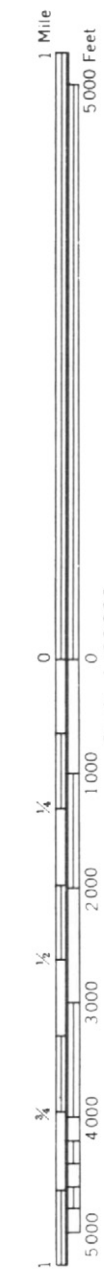

R. 3 E.
(Joins sheet 24)
(Joins sheet 30)
(Joins sheet 35)
(Joins sheet 28)
T. 13 S.
2 255 000 FEET
2 270 000 FEET
210 000 FEET
200 000 FEET
SMOKY HILL RIVER
CHICAGO ROCK ISLAND AND PACIFIC
ATCHISON TOPEKA AND SANTA FE
Enterprise
MOUNT HOPE CEMETERY
Deer Creek
Swenson Creek
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
N
1 Mile
5000 Feet
Scale 1:20000

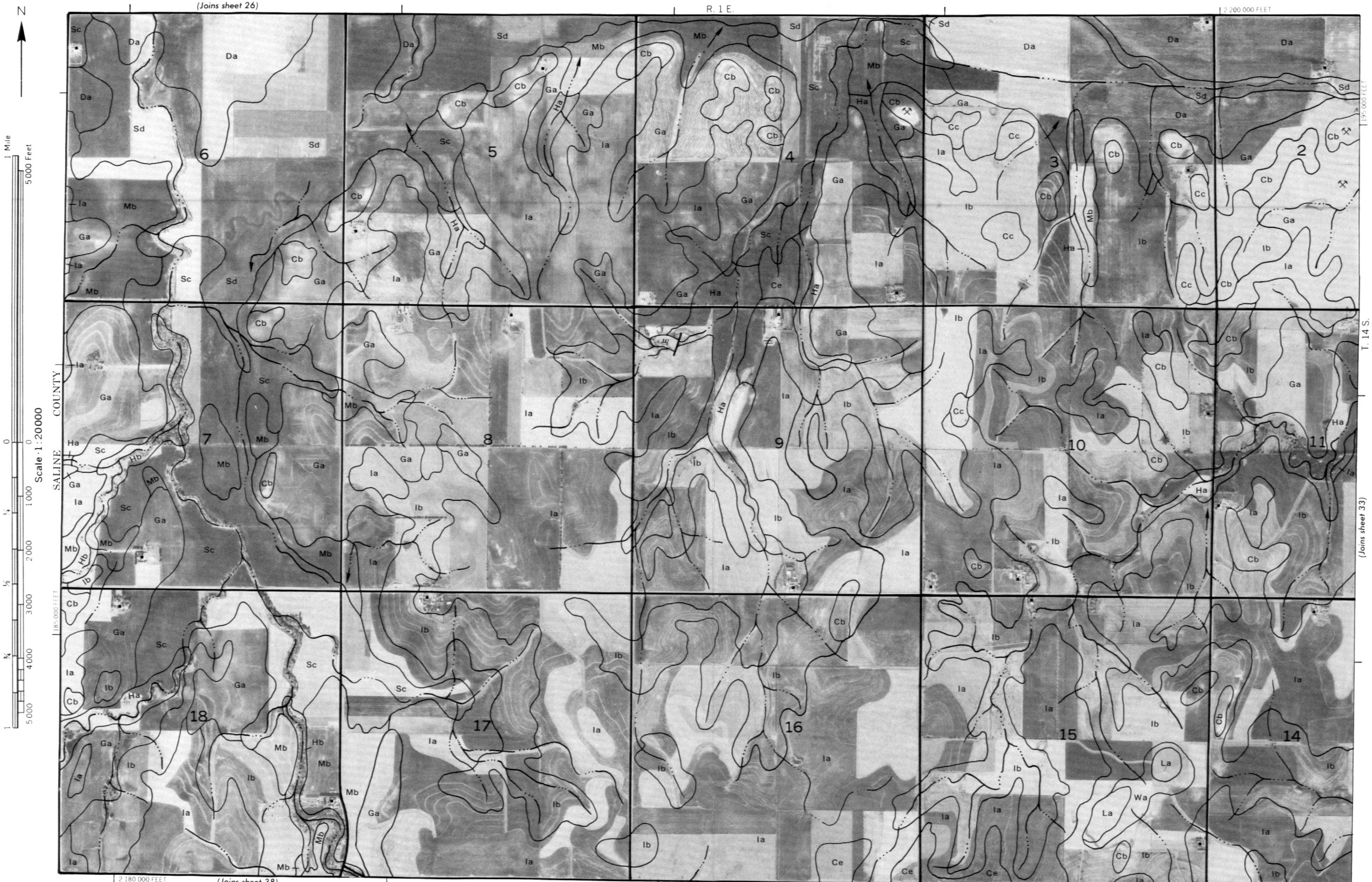

(Joins sheet 25)
R. 4 E.
2 295 000 FEET
N
1 Mile
5 000 Feet
Scale 1:20000
(Joins sheet 29)
T. 13 S.
210 000 FEET
(Joins sheet 31)
200 000 FEET
2 275 000 FEET
(Joins sheet 36)
RINEHART CEMETERY
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35


R. 4 E.
(Joins inset sheet 31)
2 300 000 FEET
T. 13 S.
(Joins sheet 30)
GEARY COUNTY
(Joins sheet 37)
2 305 000 FEET
23
24
26
25
35
36

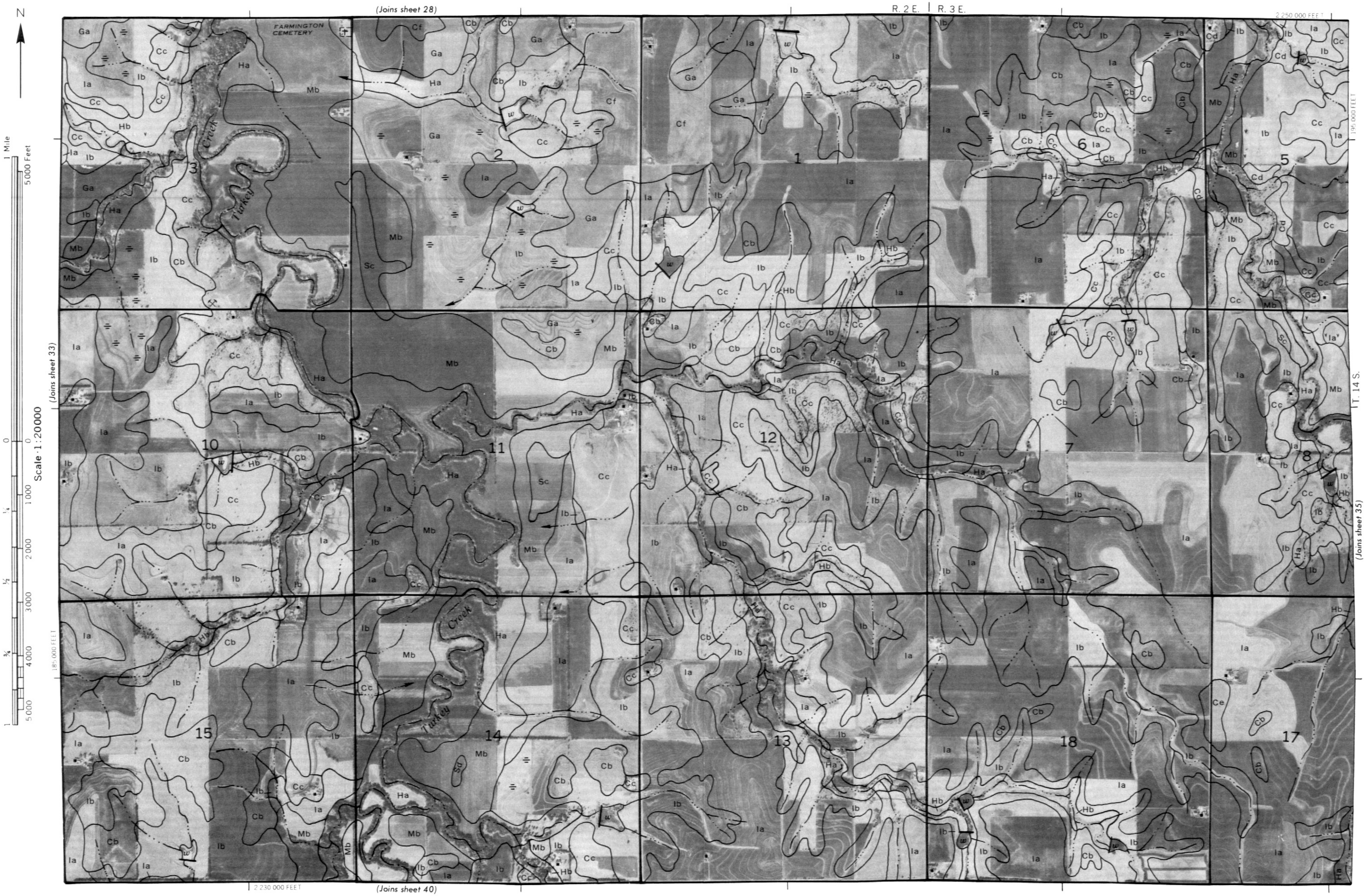

R. 4 E.
(Joins inset sheet 43)
2 300 000 FEET
T. 13 S.
(Joins sheet 25)
GEARY COUNTY
(Joins sheet 31)
2 305 000 FEET
2
1
11
12
14
13
Schuler Branch

N

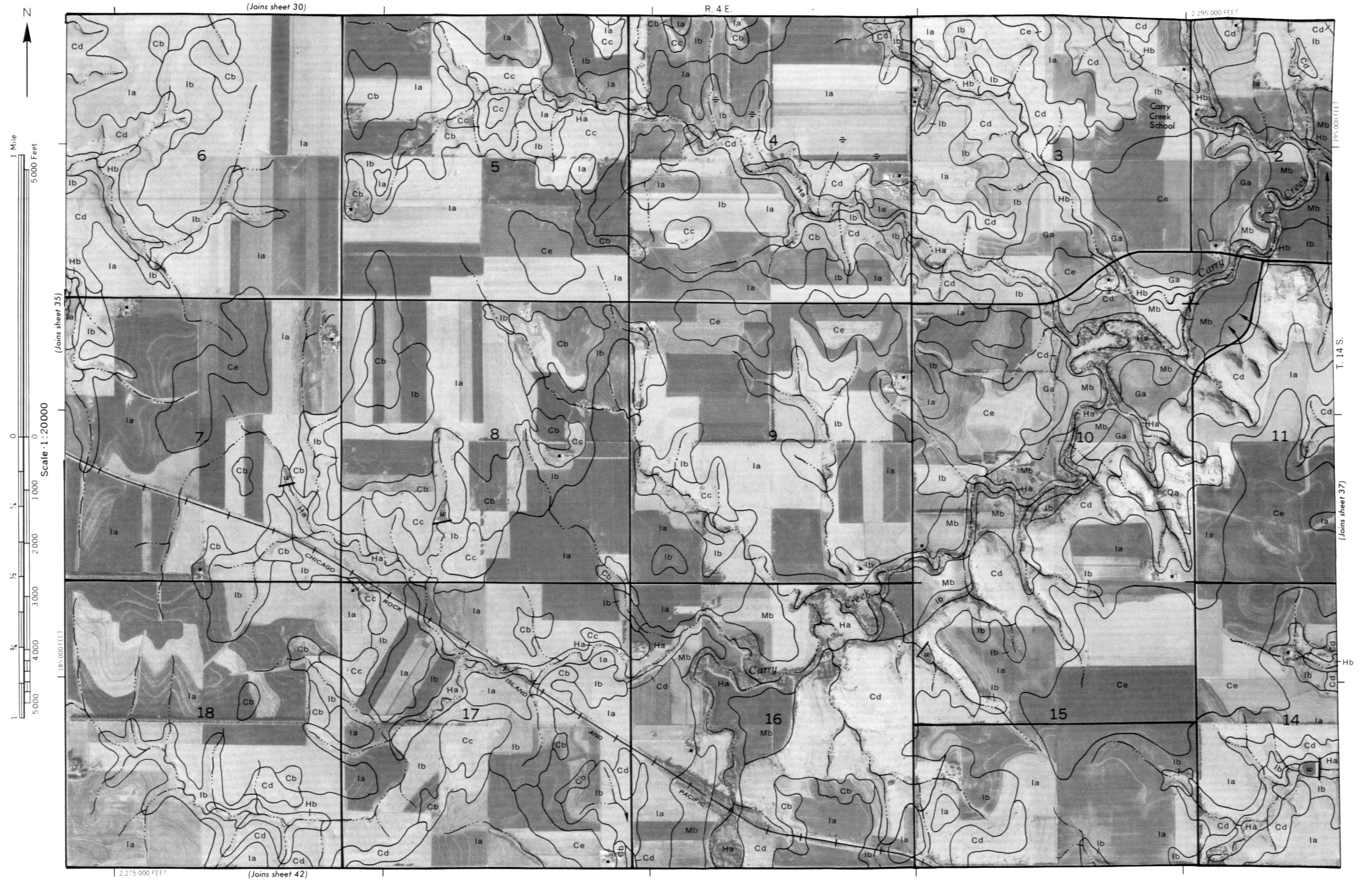

1 Mile
5 000 Feet
Scale 1:20000

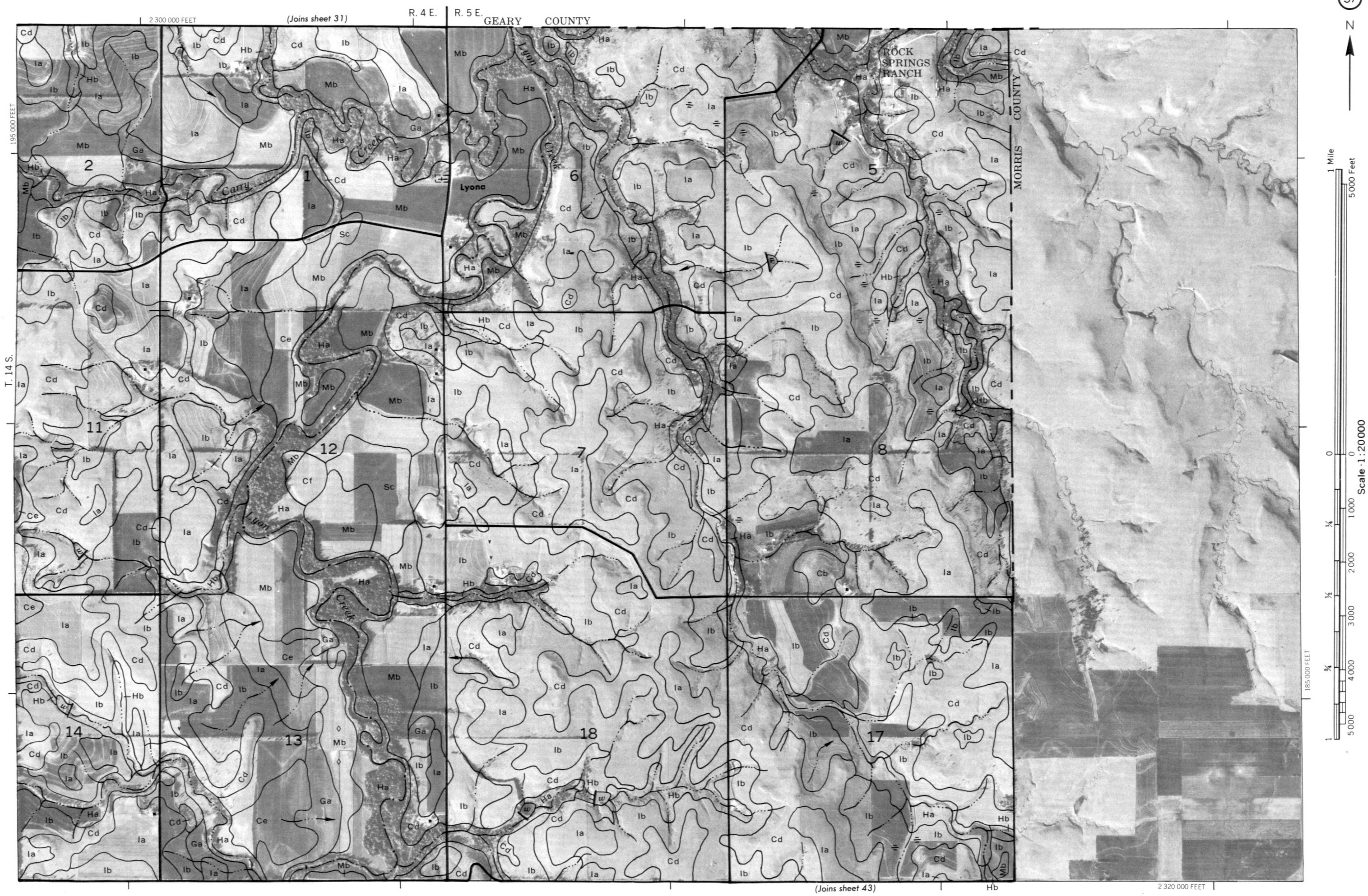

N
(Joins sheet 26)
R. 1 E.
2 200 000 FEET
195 000 FEET
T. 14 S.
(Joins sheet 33)
(Joins sheet 38)
2 180 000 FEET
185 000 FEET
SALINE COUNTY
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000


R. 1 E.
R. 2 E.
T. 14 S.
(Joins sheet 27)
(Joins sheet 34)
(Joins sheet 39)
(Joins sheet 32)
2 205 000 FEET
2 225 000 FEET
Holland Creek
Acme
N
1 Mile
5000 Feet
Scale 1:20000


N
(Joins sheet 28)
(Joins sheet 40)
(Joins sheet 33)
(Joins sheet 35)
R. 2 E. | R. 3 E.
T. 14 S.
FARMINGTON CEMETERY
Turkey Creek
Scale 1:20000
1 Mile
5000 Feet
2 250 000 FEET
2 230 000 FEET
195 000 FEET
185 000 FEET

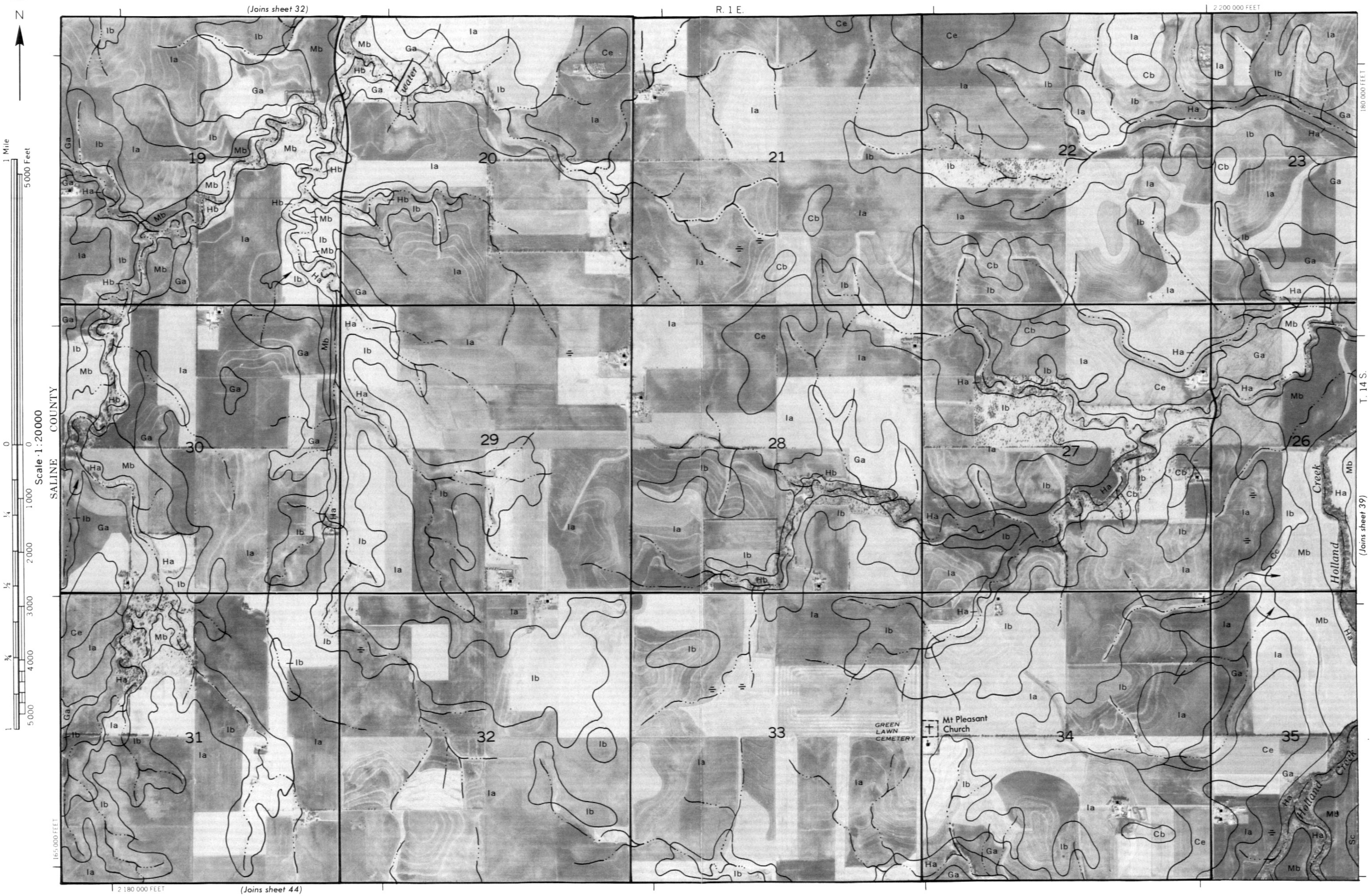

35
N
(Joins sheet 29)
R. 3 E.
2 255 000 FEET
195 000 FEET
T. 14 S.
(Joins sheet 34)
(Joins sheet 36)
(Joins sheet 41)
2 270 000 FEET
185 000 FEET
CHICAGO ROCK ISLAND AND PACIFIC
ATCHISON TOPEKA AND SANTA FE
Deer Creek
Sutphen Creek
Pearl
1 Mile
5000 Feet
Scale 1:20000

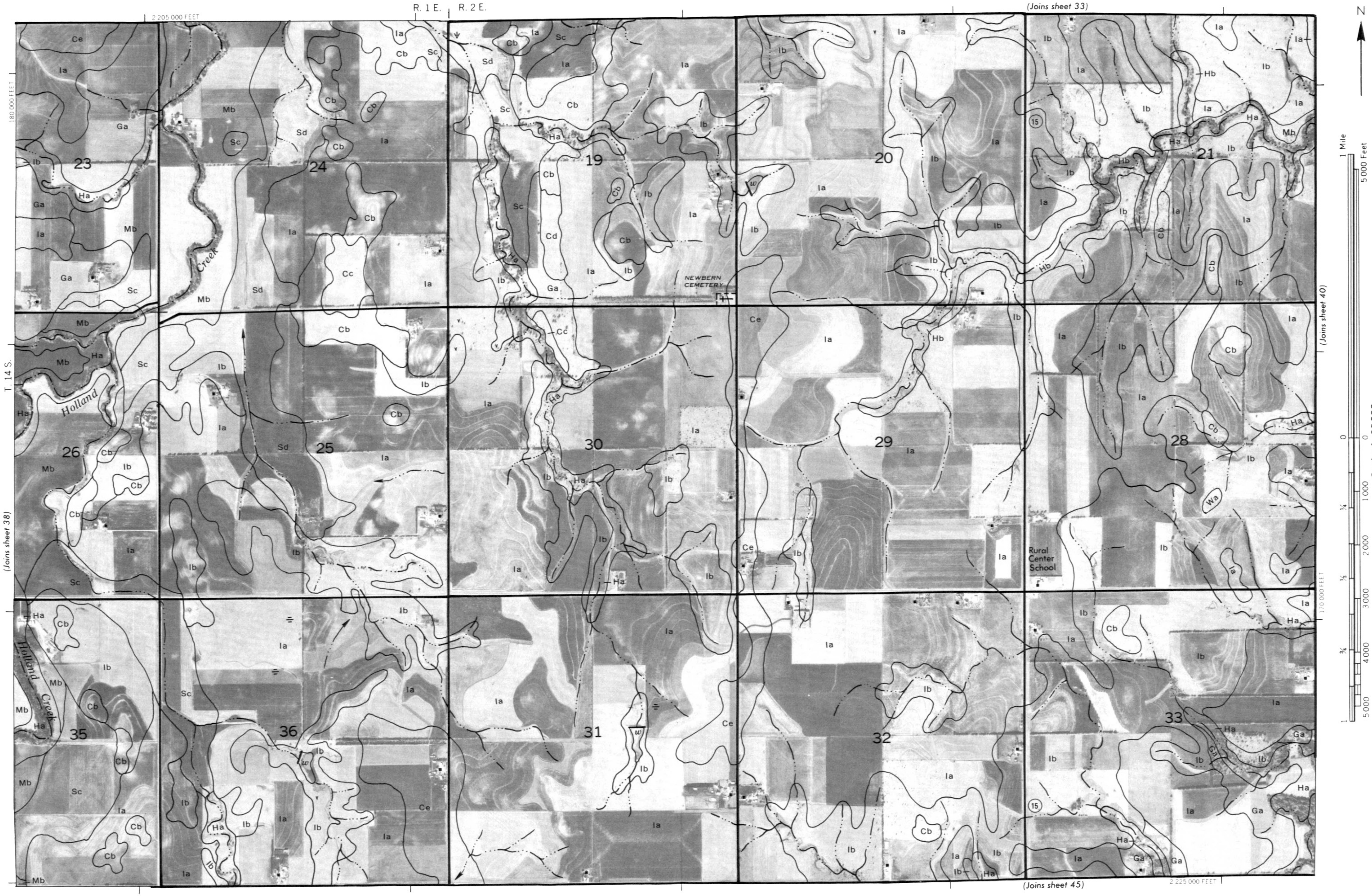

(Joins sheet 30)
R. 4 E.
2 295 000 FEET
N
1 Mile
5000 Feet
0
Scale 1:20000
(Joins sheet 35)
(Joins sheet 37)
T. 14 S.
(Joins sheet 42)
2 275 000 FEET
185 000 FEET
Carry Creek School
Carry Creek
CHICAGO ROCK ISLAND AND PACIFIC
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14


37
(Joins sheet 31)
R. 4 E.
R. 5 E.
GEARY COUNTY
MORRIS COUNTY
ROCK SPRINGS RANCH
Lyona
Lyon Creek
Carry Creek
T. 14 S.
2 300 000 FEET
2 320 000 FEET
195 000 FEET
185 000 FEET
(Joins sheet 43)
N
1 Mile
5000 Feet
Scale 1:20000
1 2 5 6 7 8 11 12 13 14 17 18
Ia Ib Cd Mb Ha Hb Ga Sc Ce Cf Cb

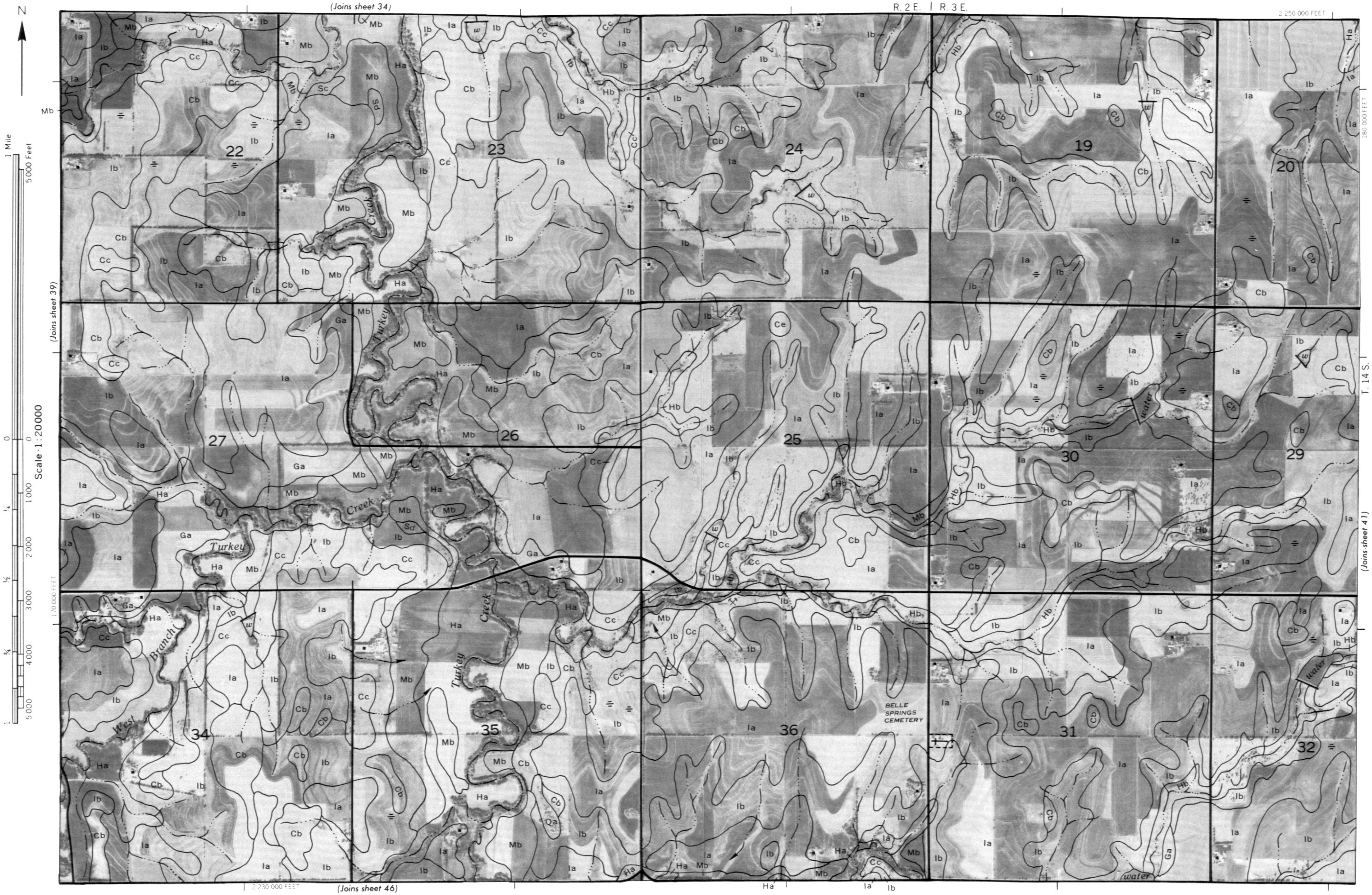
38

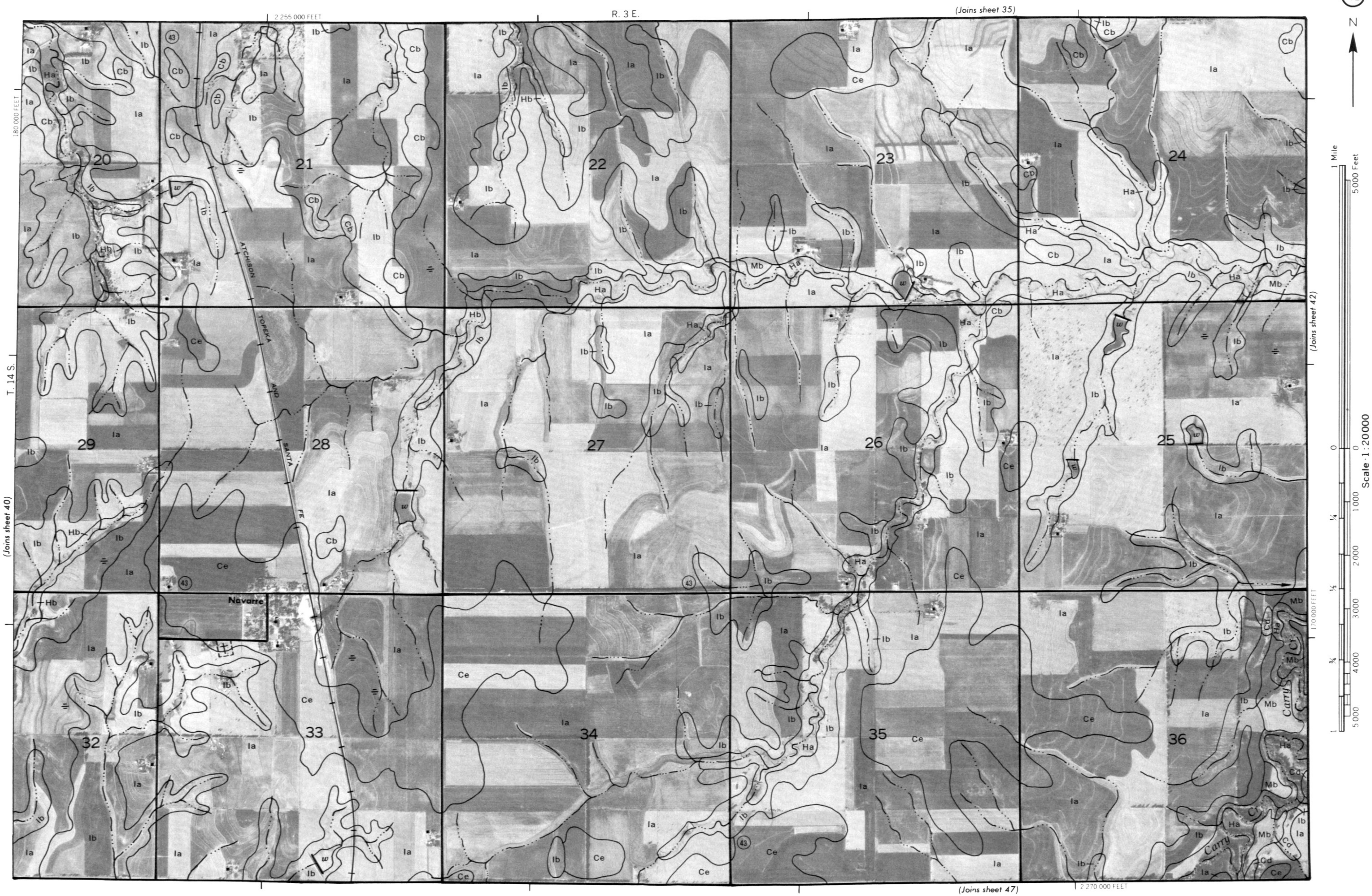
DICKINSON COUNTY, KANSAS — SHEET NUMBER 38

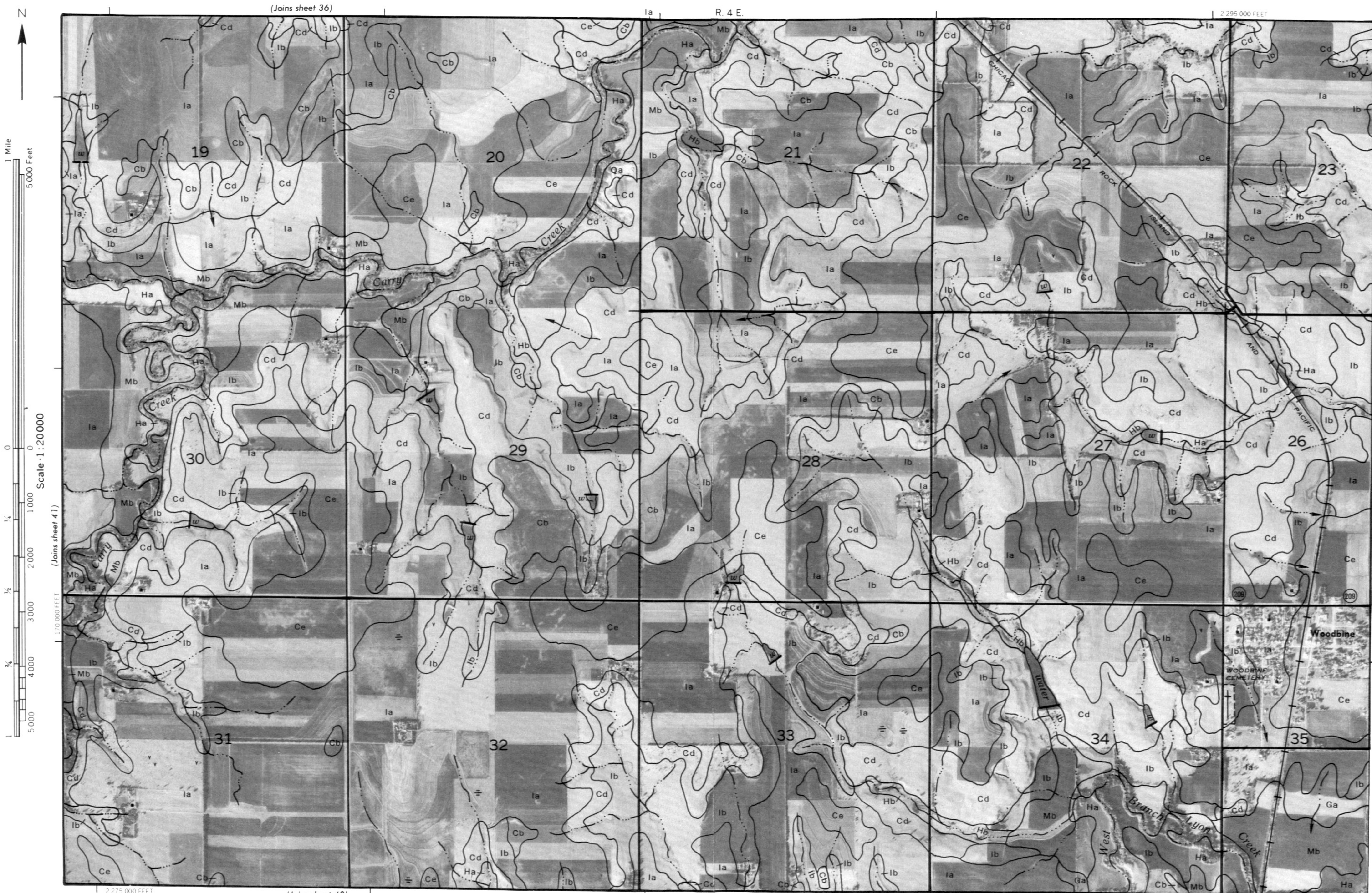


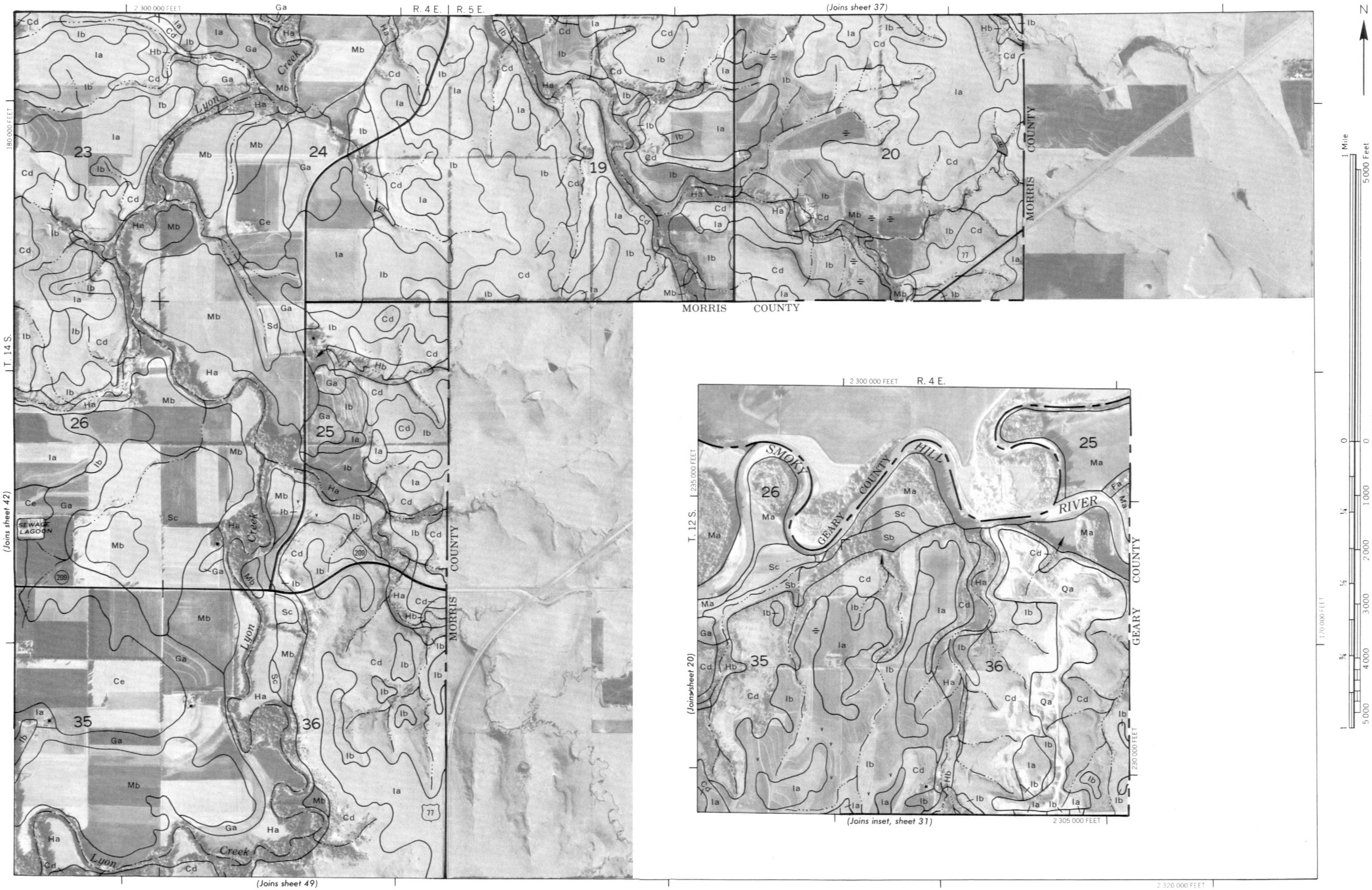


N
(Joins sheet 33)
(Joins sheet 40)
(Joins sheet 45)
(Joins sheet 38)
R. 1 E.
R. 2 E.
T. 14 S.
2 205 000 FEET
2 225 000 FEET
180 000 FEET
170 000 FEET
NEWBERN CEMETERY
Rural Center School
Holland Creek
Creek
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
15
1 Mile
5000 Feet
Scale 1:20000

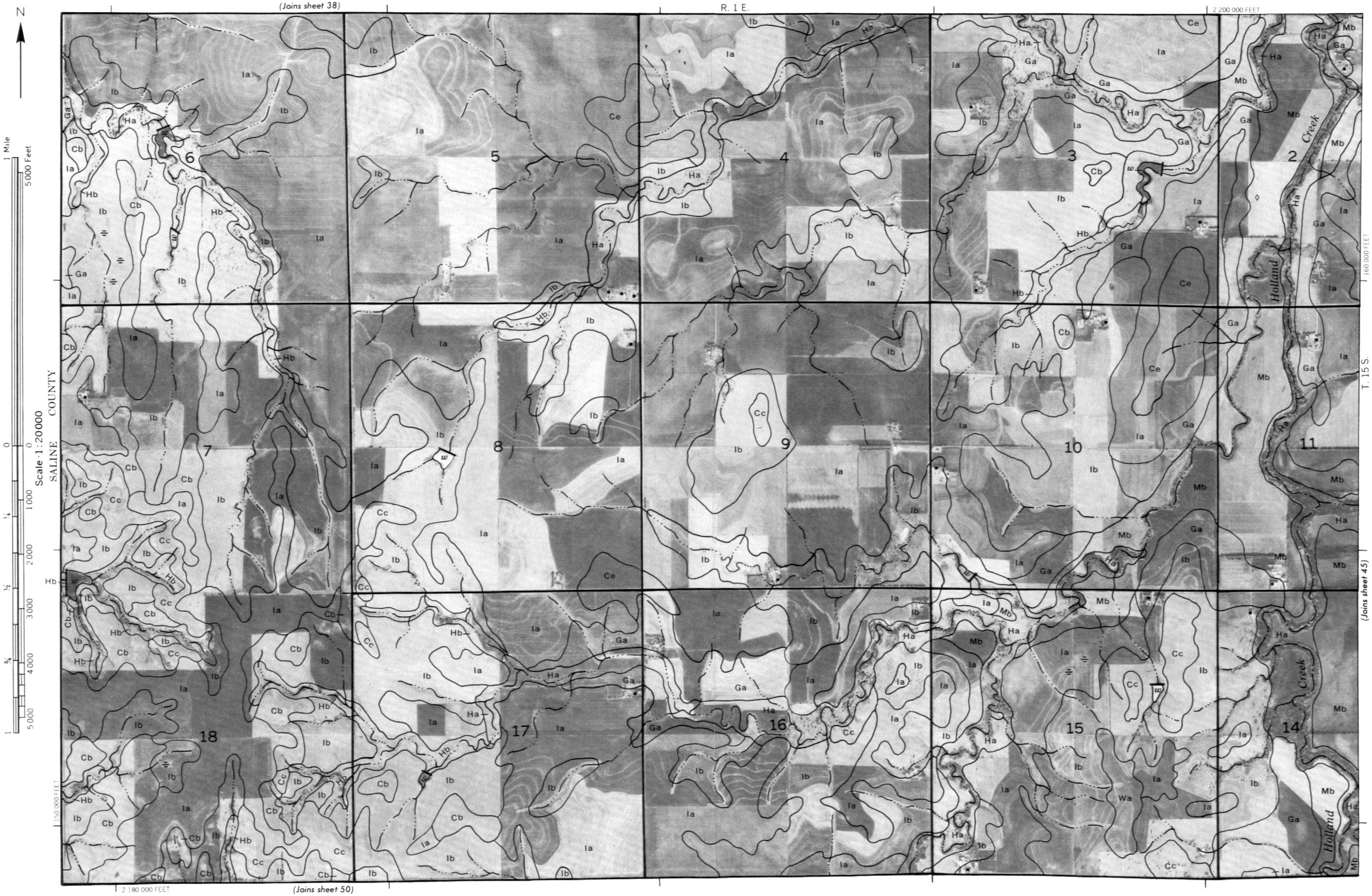

(Joins sheet 34)
R. 2 E.
R. 3 E.
2 250 000 FEET
180 000 FEET
N
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 46)
T. 14 S.
Scale 1:20000
1 Mile
5 000 Feet
170 000 FEET
2 230 000 FEET
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
Turkey Creek
Turkey Creek
Turkey Creek
West Branch
BELLE SPRINGS CEMETERY
water
w


41
N
(Joins sheet 35)
(Joins sheet 42)
(Joins sheet 47)
(Joins sheet 40)
R. 3 E.
T. 14 S.
2 255 000 FEET
2 270 000 FEET
180 000 FEET
170 000 FEET
ATCHISON TOPEKA AND SANTA FE
Navarre
Carry Cr.
1 Mile
5000 Feet
Scale 1:20000
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36

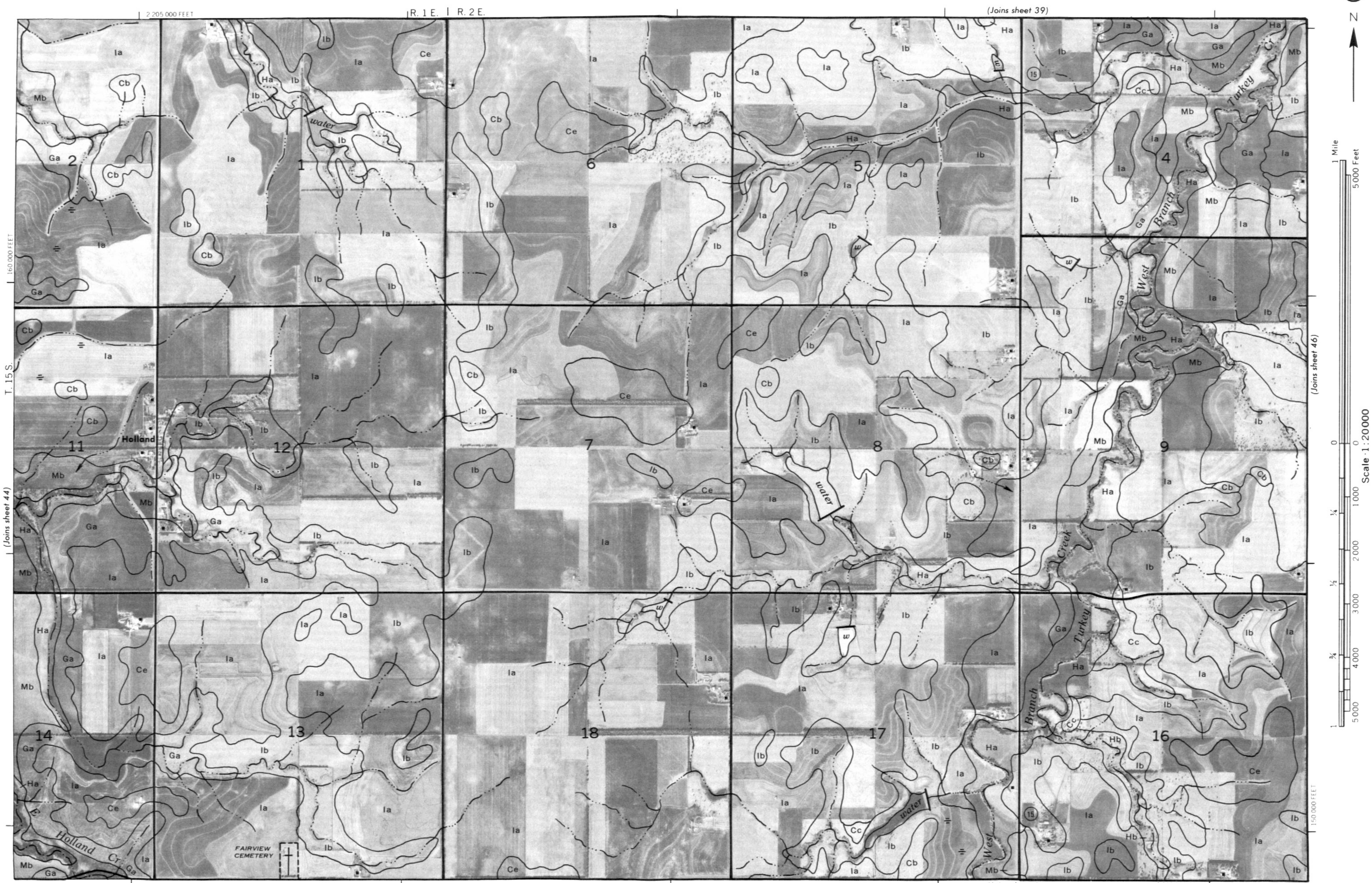

N
(Joins sheet 36)
R. 4 E.
2 295 000 FEET
180 000 FEET
T. 14 S.
(Joins sheet 43)
(Joins sheet 41)
(Joins sheet 48)
170 000 FEET
2 275 000 FEET
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
Carry Creek
Creek
West Branch Lyon Creek
CHICAGO ROCK ISLAND AND PACIFIC
Woodbine
WOODBINE CEMETERY
Water
209
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35



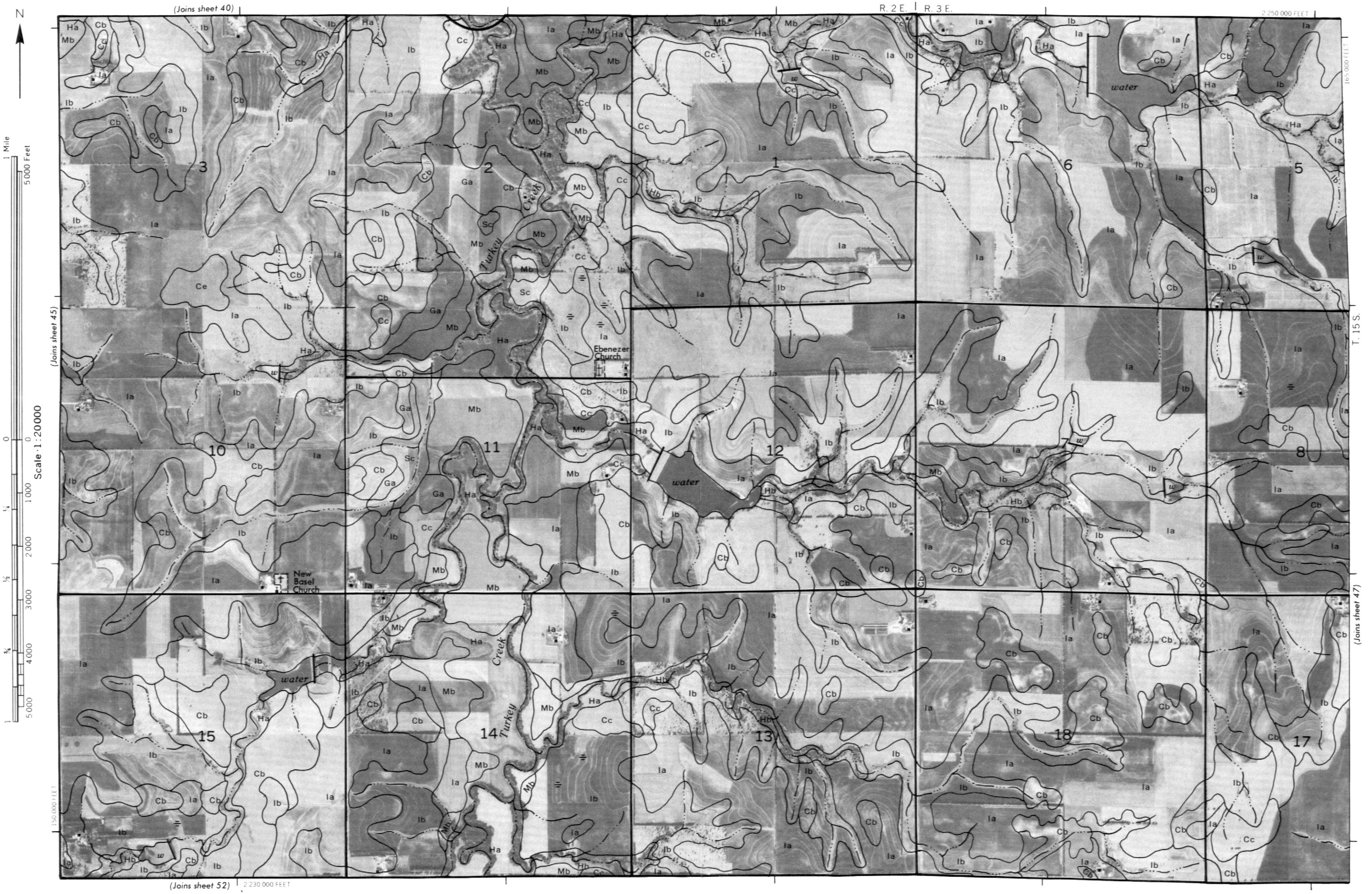
(Joins sheet 37)
(Joins sheet 42)
(Joins sheet 49)
(Joins sheet 20)
(Joins inset, sheet 31)
R. 4 E.
R. 5 E.
T. 14 S.
T. 12 S.
2 300 000 FEET
180 000 FEET
235 000 FEET
230 000 FEET
170 000 FEET
2 305 000 FEET
2 320 000 FEET
MORRIS COUNTY
GEARY COUNTY
SMOKY HILL RIVER
Lyon Creek
SEWAGE LAGOON
N
Scale 1:20000
1 Mile
5000 Feet

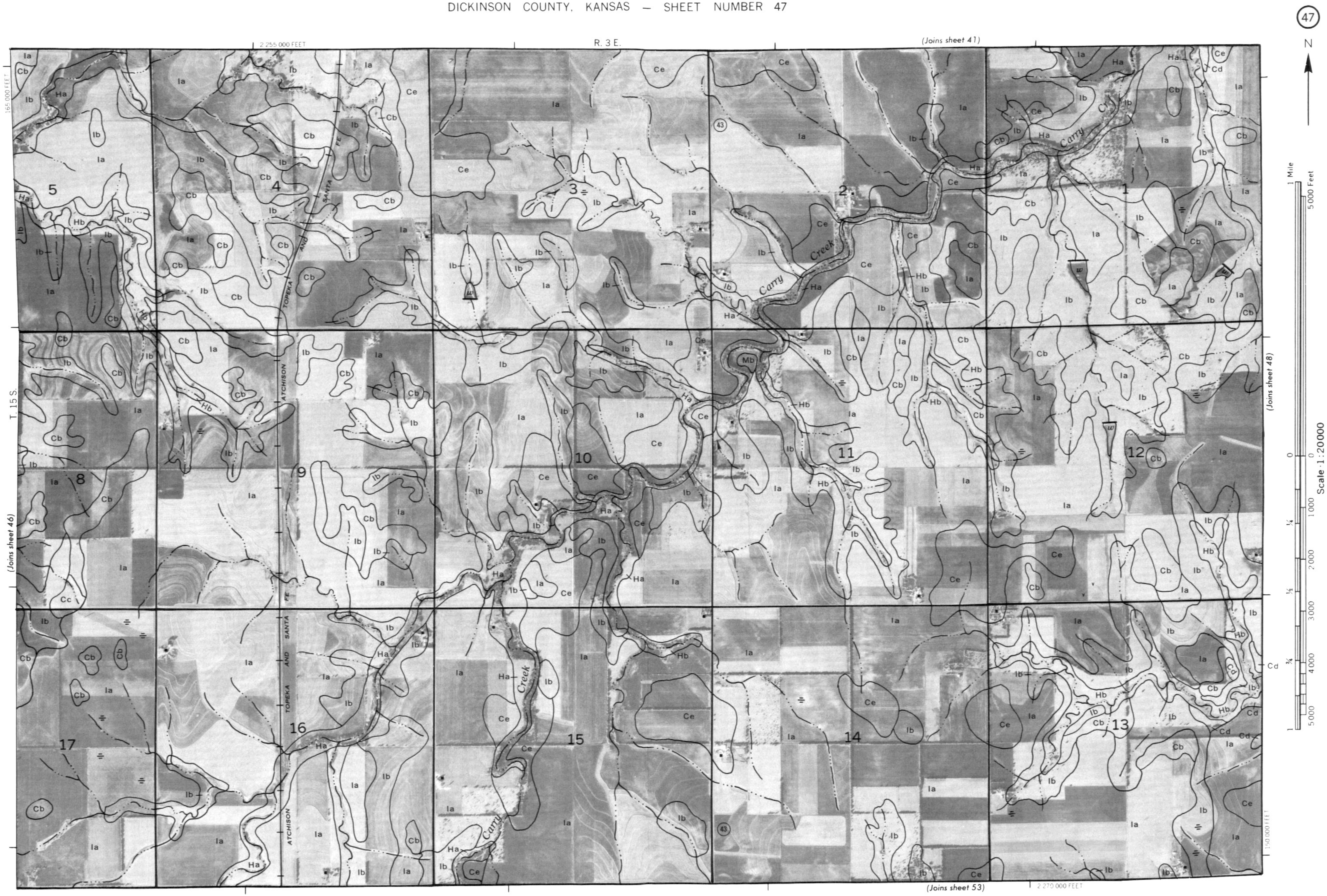

N
(Joins sheet 38)
R. 1 E.
2 200 000 FEET
160 000 FEET
T. 15 S.
(Joins sheet 45)
(Joins sheet 50)
2 180 000 FEET
150 000 FEET
SALINE COUNTY
Scale 1:20000
1 Mile
5000 Feet
Holland Creek
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14

DICKINSON COUNTY, KANSAS — SHEET NUMBER 45

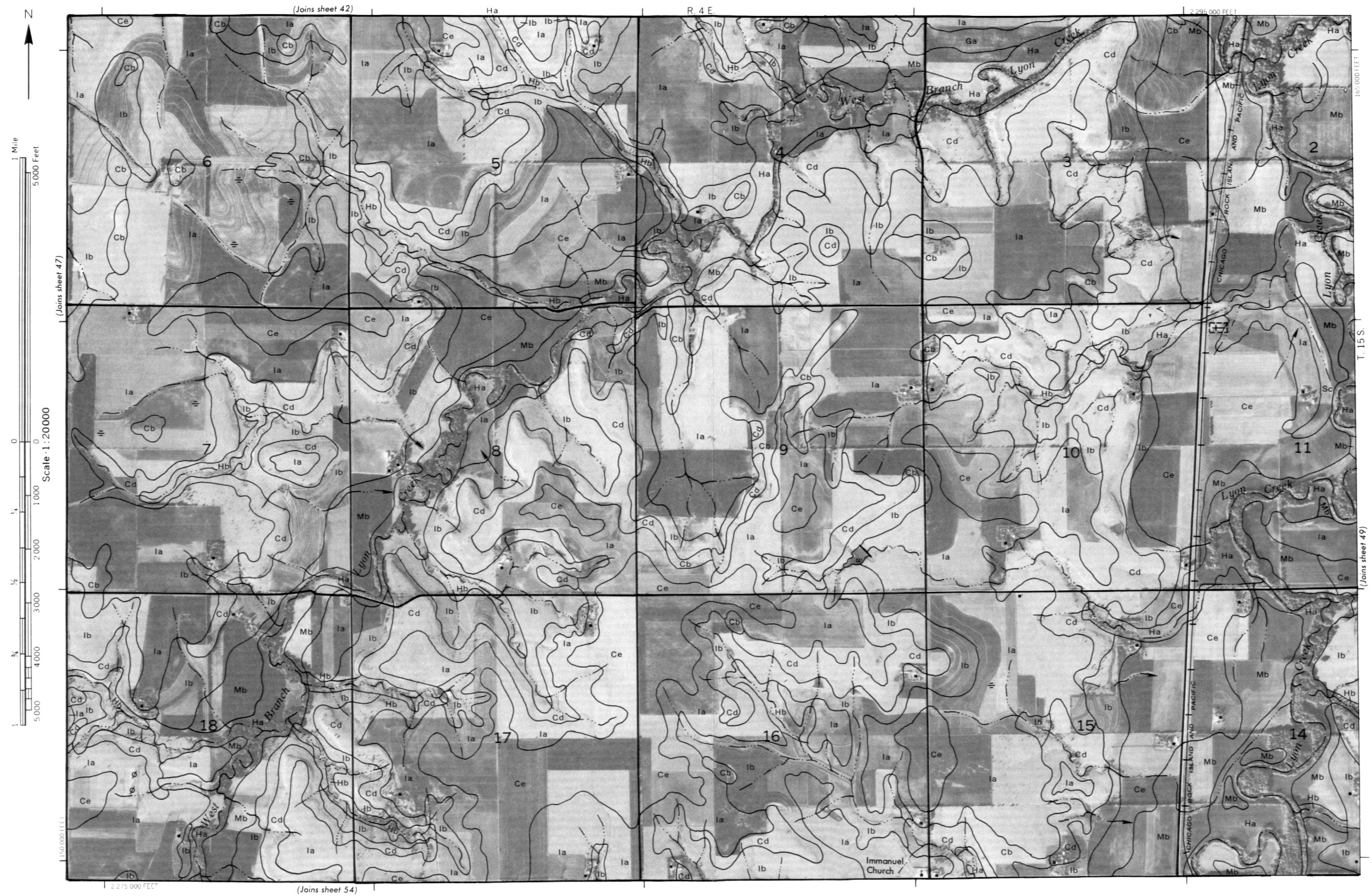


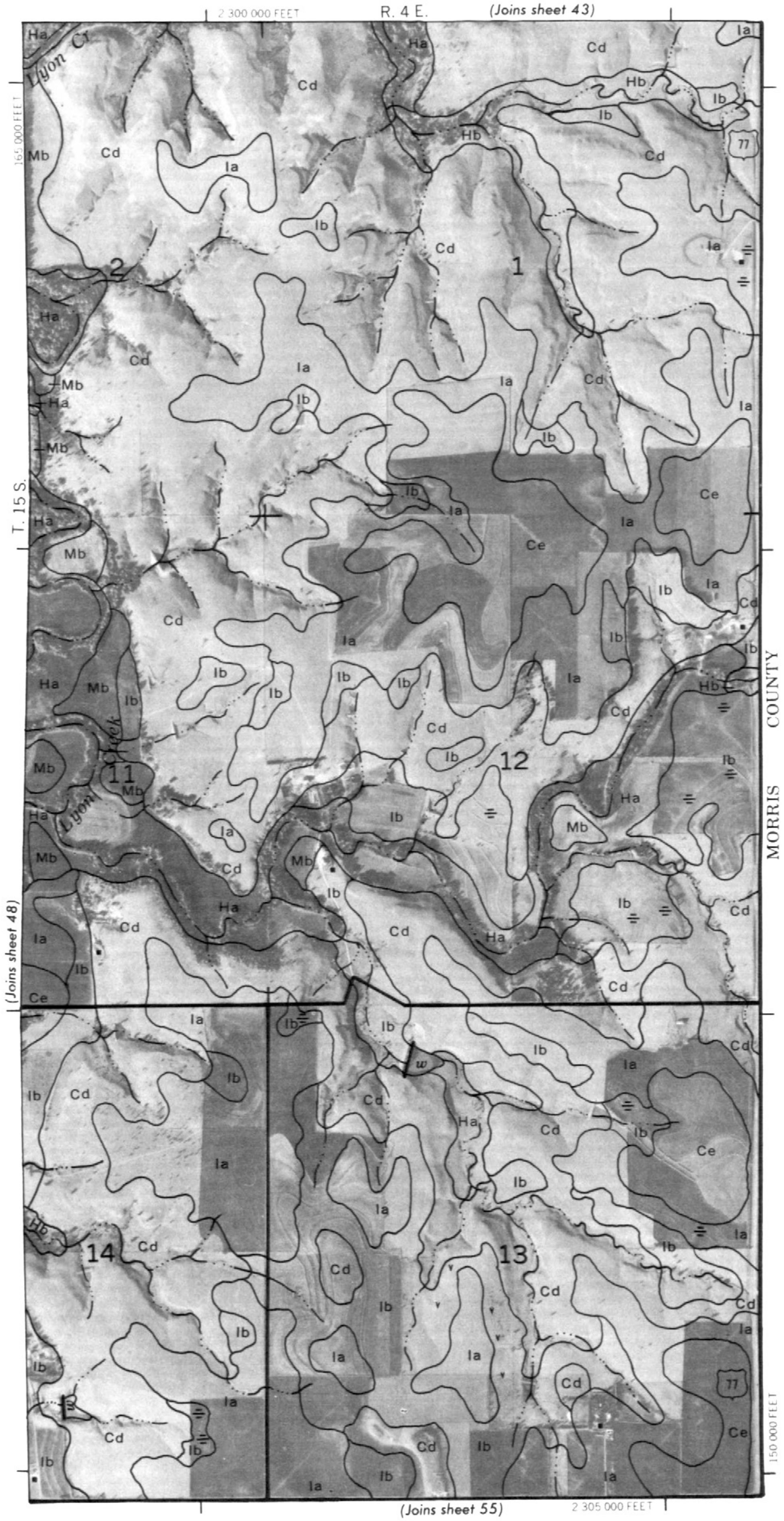
DICKINSON COUNTY, KANSAS — SHEET NUMBER 46

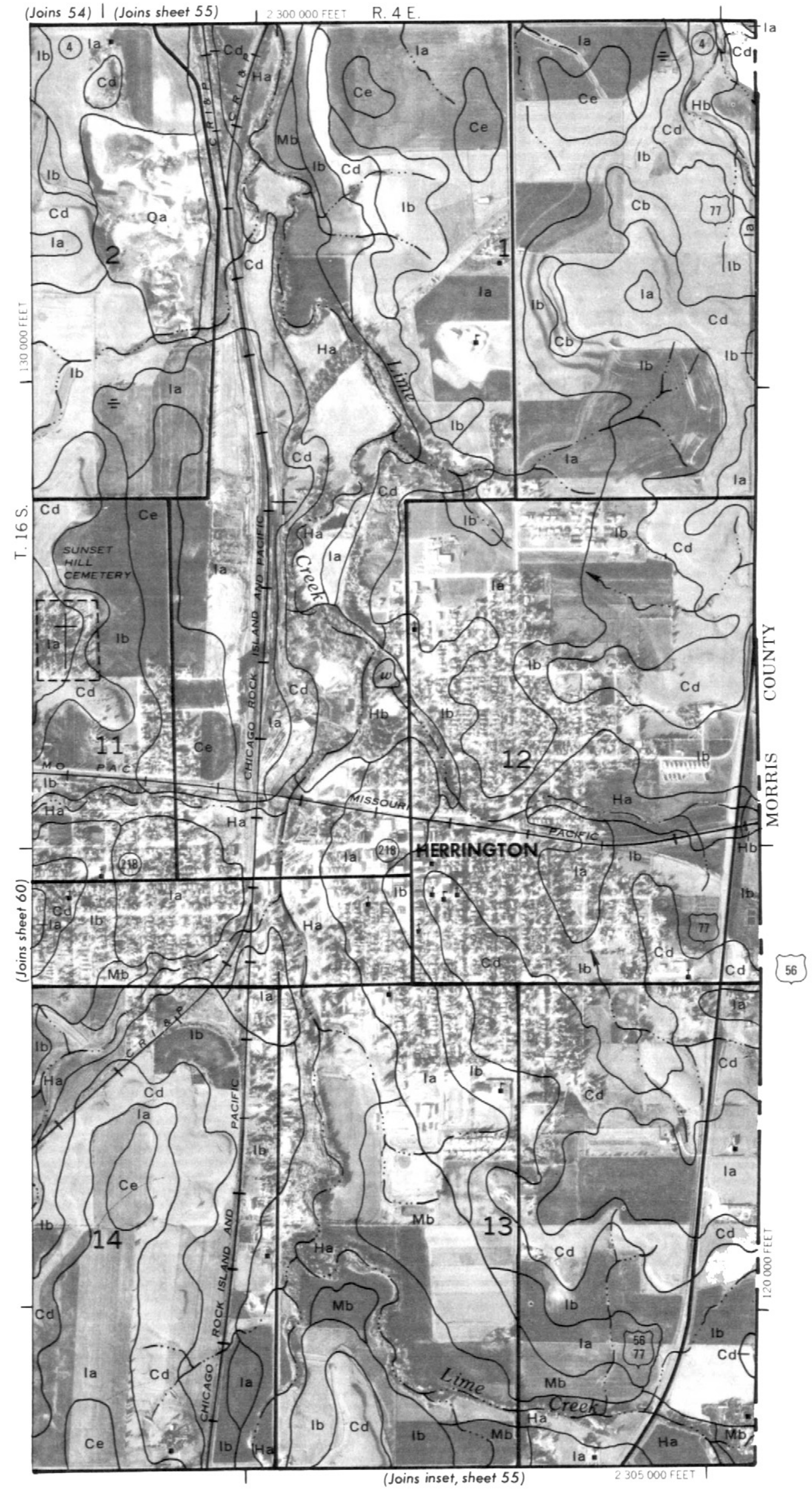


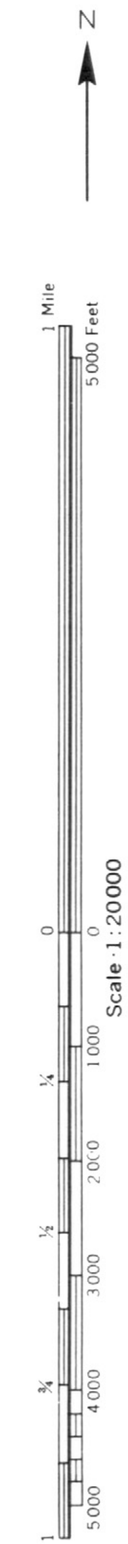

47
N
2 255 000 FEET
R. 3 E.
(Joins sheet 41)
165 000 FEET
T. 15 S.
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 53)
2 270 000 FEET
150 000 FEET
ATCHISON TOPEKA AND SANTA FE
Carry Creek
Carry Cr.
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
1000
2000
3000
4000
5000
43
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

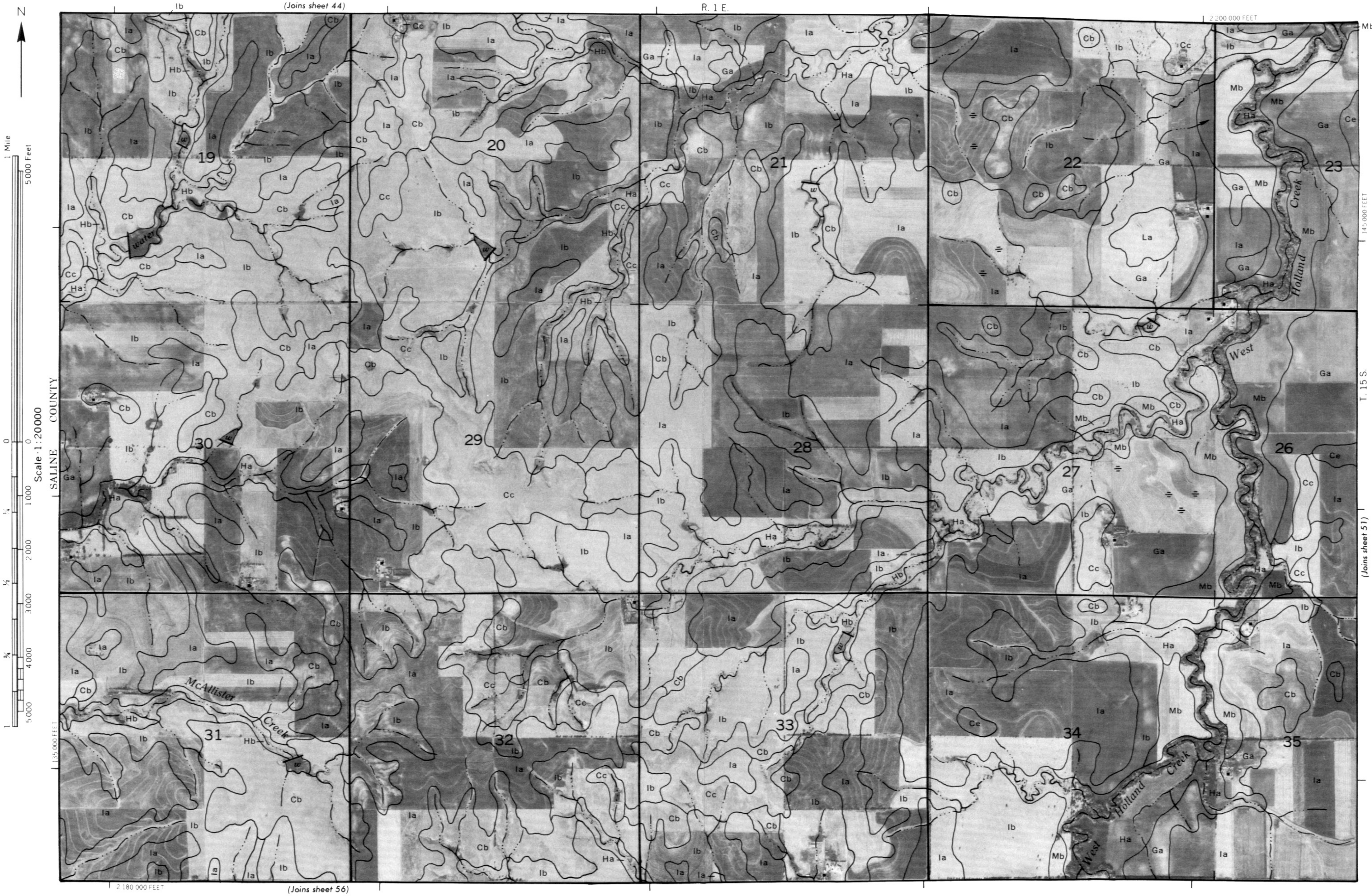
DICKINSON COUNTY, KANSAS — SHEET NUMBER 48

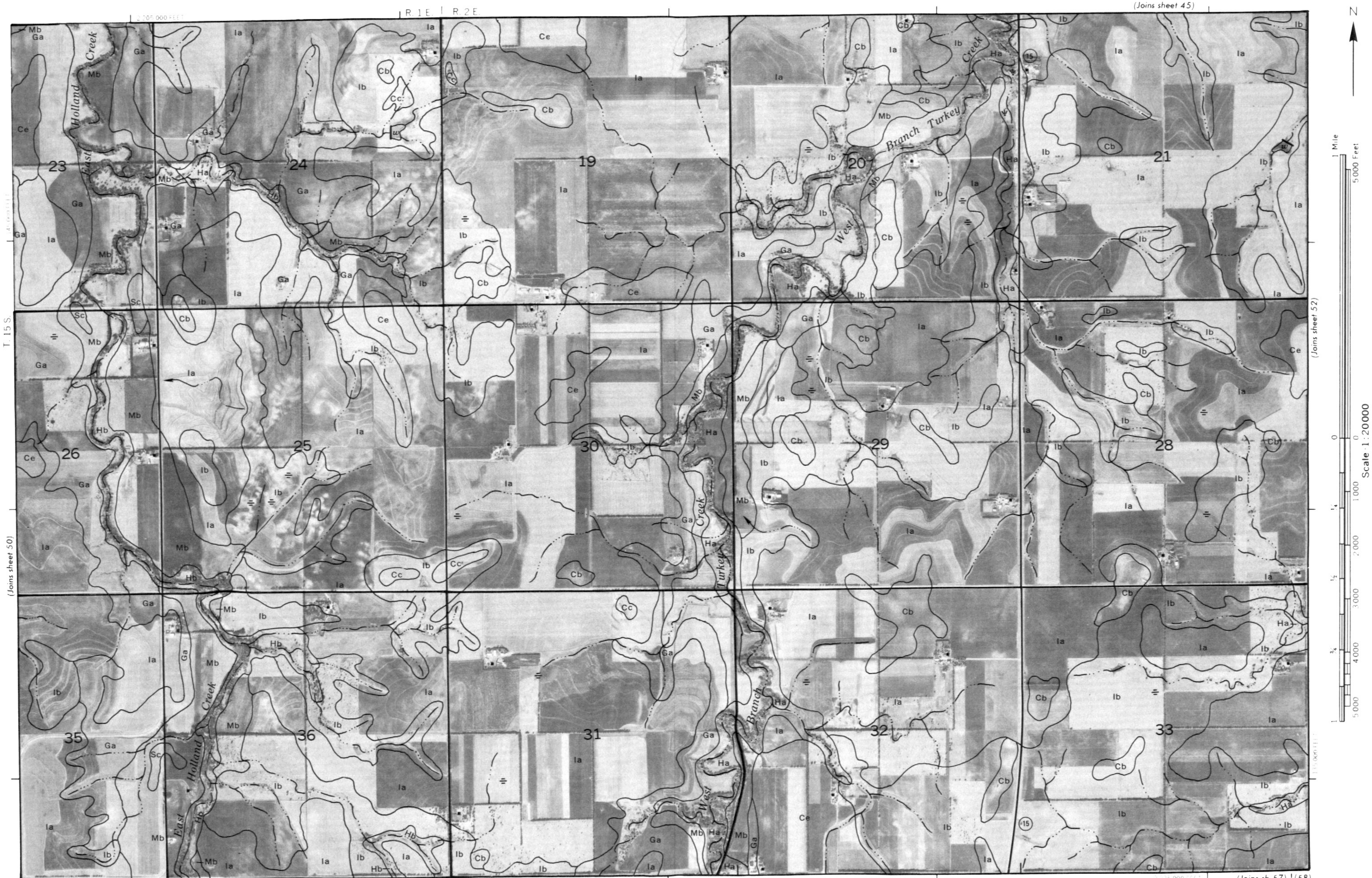


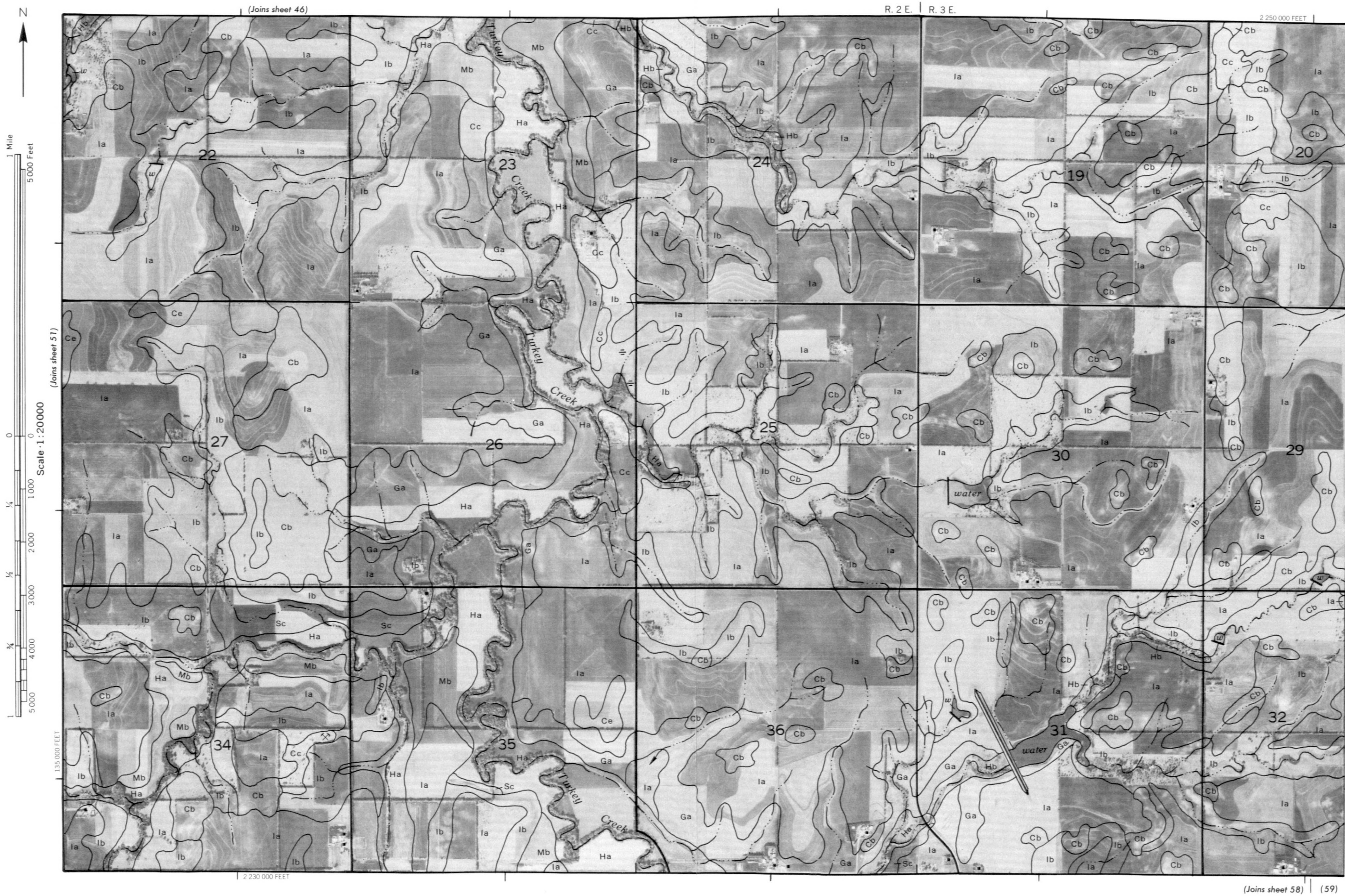

(Joins sheet 43)
R. 4 E.
2 300 000 FEET
165 000 FEET
T. 15 S.
Lyon Cr.
Lyon Creek
MORRIS COUNTY
(Joins sheet 48)
(Joins sheet 55)
2 305 000 FEET
150 000 FEET
1
2
11
12
13
14


(Joins 54)
(Joins sheet 55)
2 300 000 FEET
R. 4 E.
130 000 FEET
T. 16 S.
SUNSET HILL CEMETERY
CHICAGO ROCK ISLAND AND PACIFIC
MISSOURI PACIFIC
Lime Creek
HERRINGTON
MORRIS COUNTY
(Joins sheet 60)
120 000 FEET
(Joins inset, sheet 55)
2 305 000 FEET
1
2
11
12
13
14


N
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
Scale 1:20000

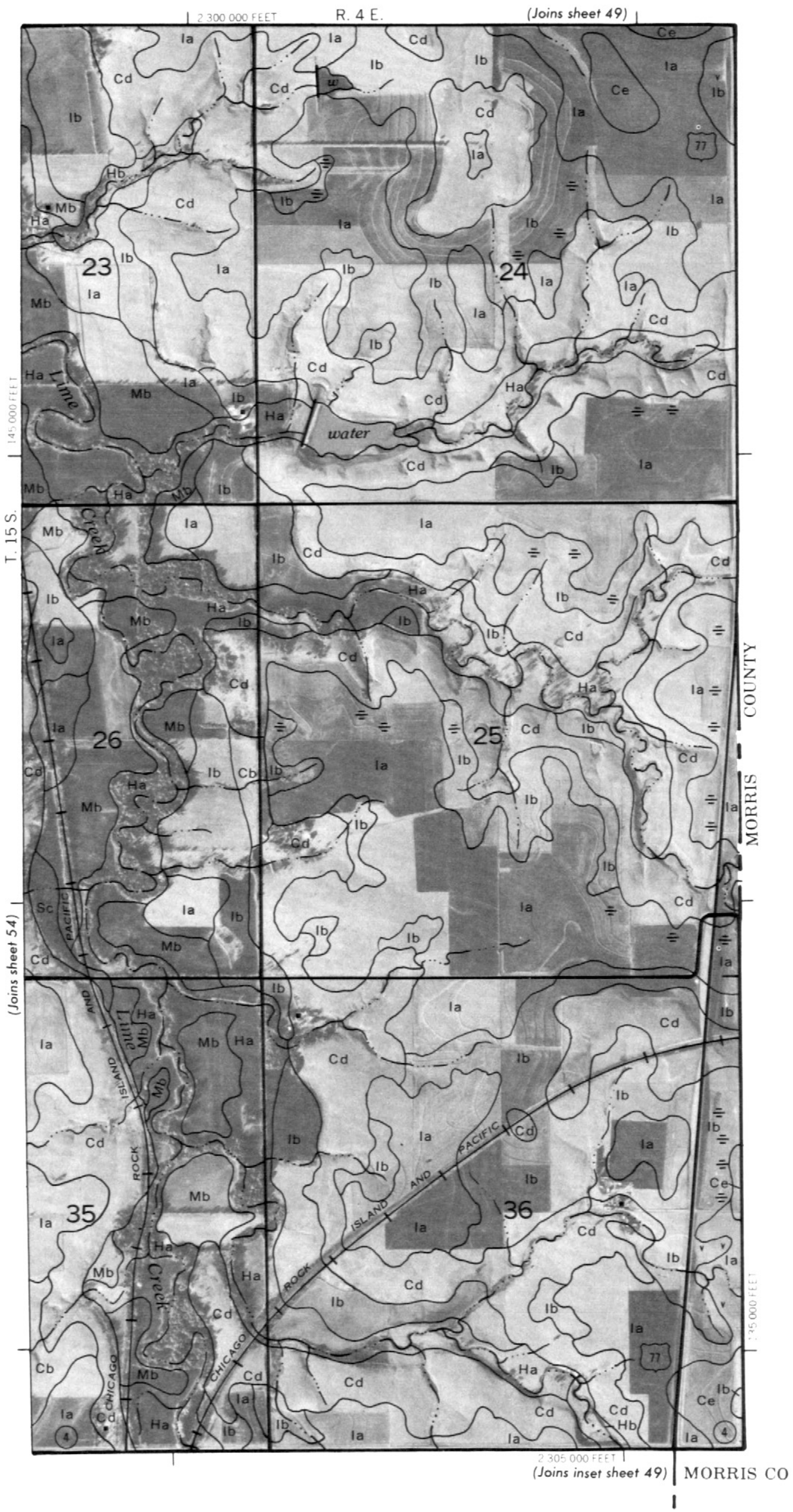

N
(Joins sheet 44)
R. 1 E.
2 200 000 FEET
145 000 FEET
T. 15 S.
(Joins sheet 51)
(Joins sheet 56)
2 180 000 FEET
135 000 FEET
SALINE COUNTY
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
water
McAllister Creek
Holland Creek
West Holland Creek
West Holland Creek
Ia
Ib
Cb
Cc
Ce
Ga
Ha
Hb
La
Mb
w

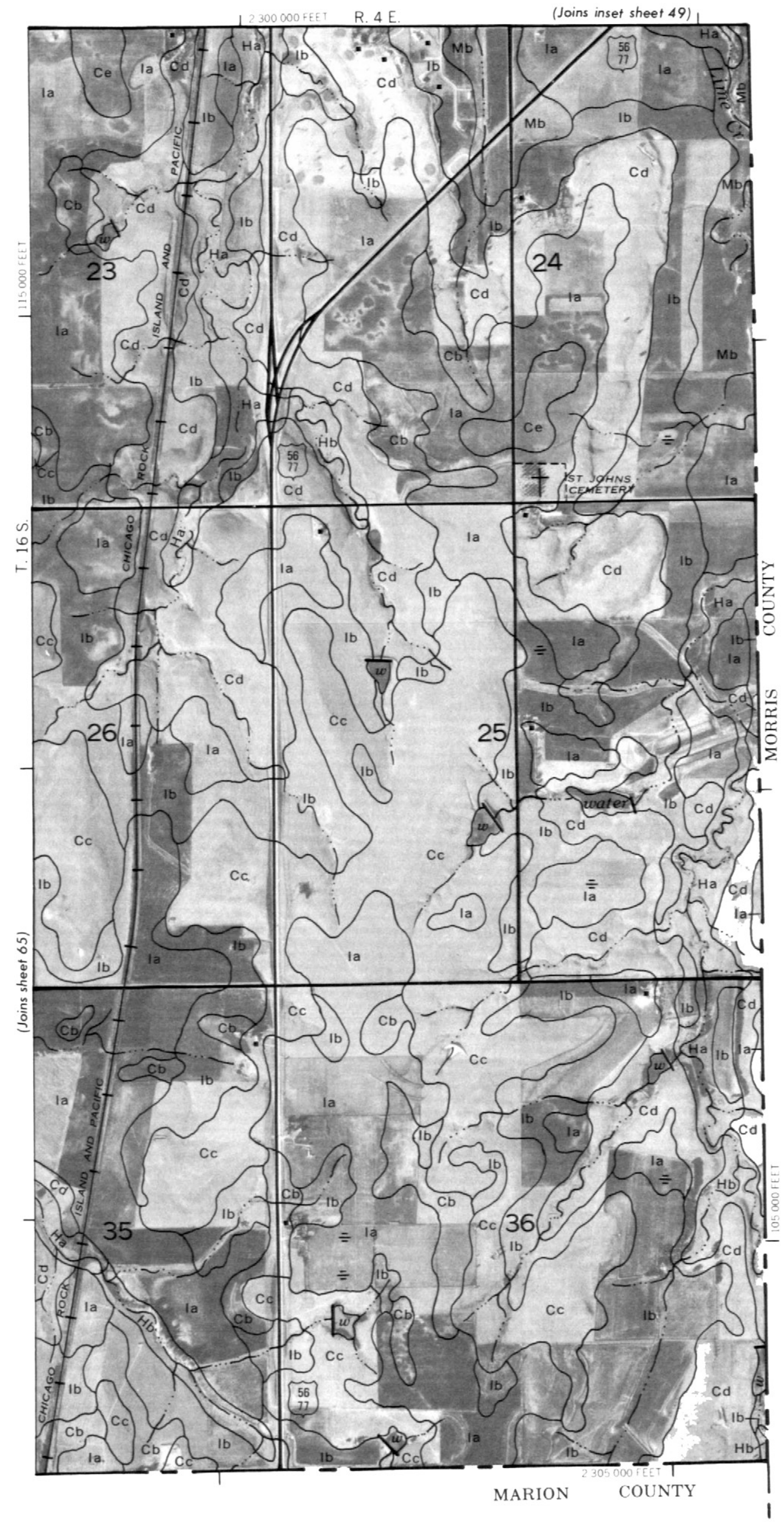

R. 1 E.
R. 2 E.
T. 15 S.
(Joins sheet 45)
(Joins sheet 52)
(Joins sheet 50)
(Joins sh 57)
(58)
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
East Holland Creek
West Branch Turkey Creek
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
15

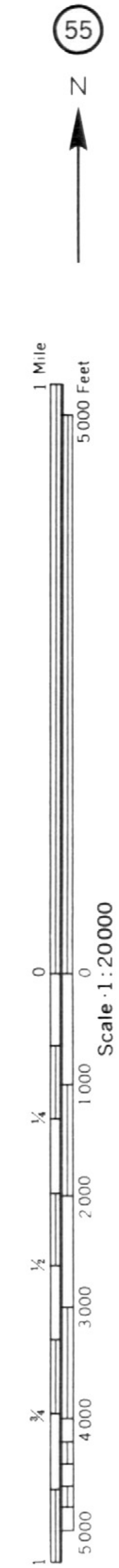

N
(Joins sheet 46)
R. 2 E.
R. 3 E.
2 250 000 FEET
(Joins sheet 51)
(Joins sheet 53)
145 000 FEET
T. 15 S.
135 000 FEET
2 230 000 FEET
(Joins sheet 58)
(59)
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1000
2000
3000
4000
5000
Turkey Creek
water
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36

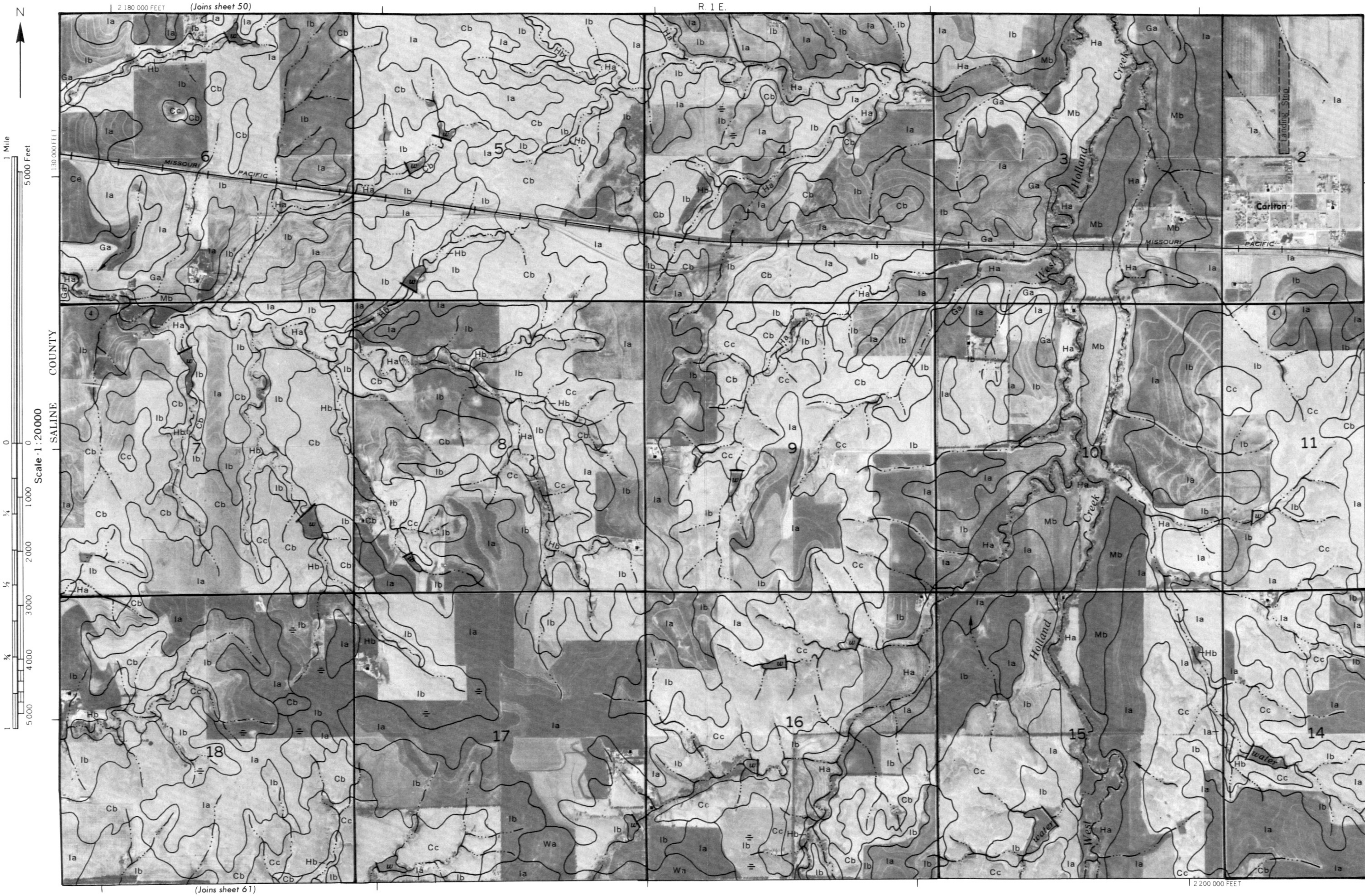
DICKINSON COUNTY, KANSAS — SHEET NUMBER 53

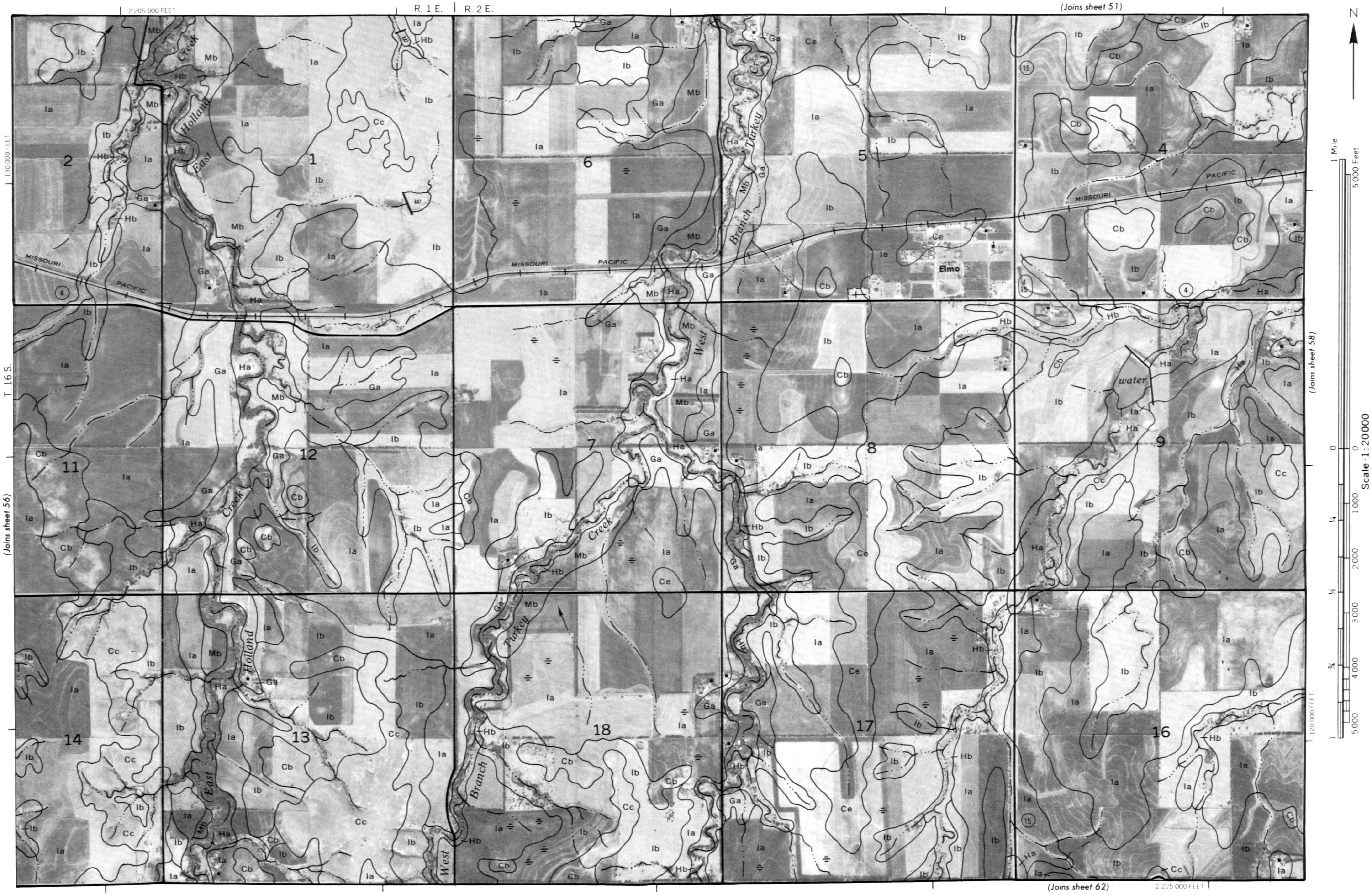
DICKINSON COUNTY, KANSAS — SHEET NUMBER 54


2 300 000 FEET
R. 4 E.
(Joins sheet 49)
T. 15 S.
145 000 FEET
(Joins sheet 54)
Lime Creek
water
23
24
25
26
35
36
ROCK ISLAND AND PACIFIC
CHICAGO
COUNTY
MORRIS
2 305 000 FEET
(Joins inset sheet 49)
MORRIS CO


2 300 000 FEET
R. 4 E.
(Joins inset sheet 49)
T. 16 S.
115 000 FEET
(Joins sheet 65)
CHICAGO ROCK ISLAND AND PACIFIC
Lime Cr
ST JOHNS CEMETERY
water
23
24
25
26
35
36
MORRIS
COUNTY
105 000 FEET
2 305 000 FEET
MARION
COUNTY

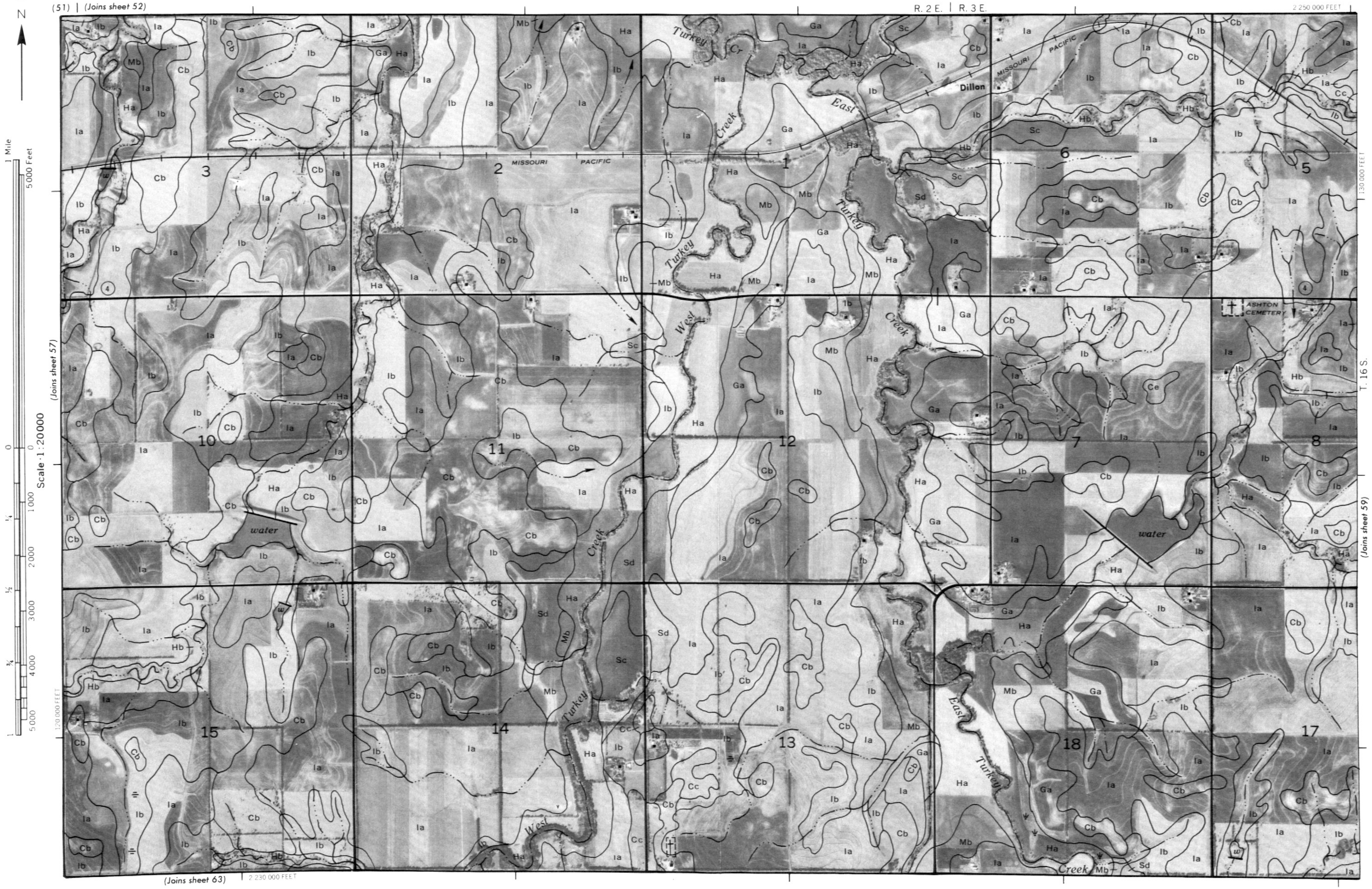

55
N
1 Mile
5000 Feet
Scale 1:20000

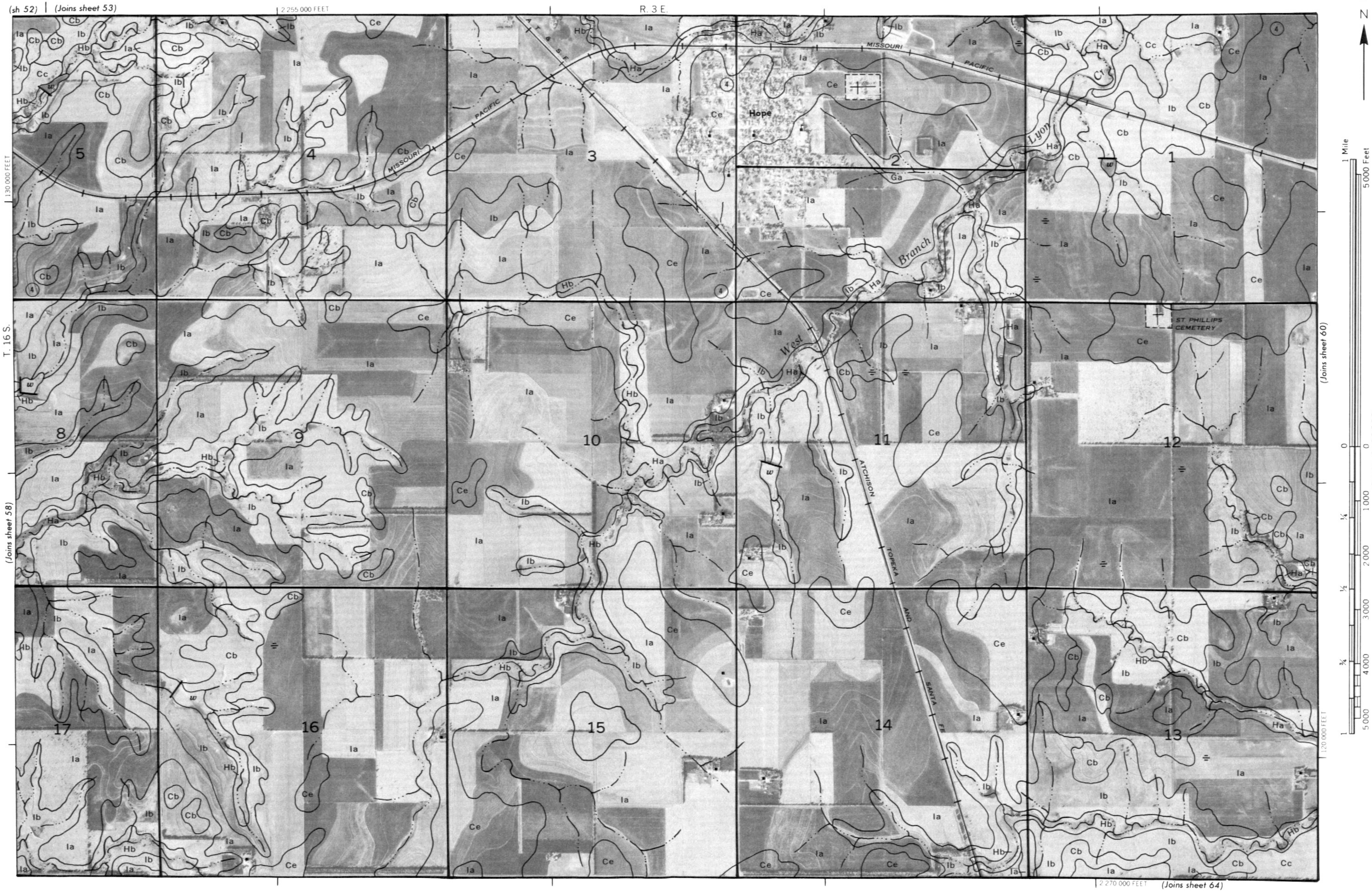

N
(Joins sheet 50)
2 180 000 FEET
R. 1 E.
T. 16 S.
(Joins sheet 57)
(Joins sheet 61)
2 200 000 FEET
130 000 FEET
120 000 FEET
SALINE COUNTY
MISSOURI PACIFIC
Holland Creek
West Holland Creek
Carlton
Landing Strip
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000

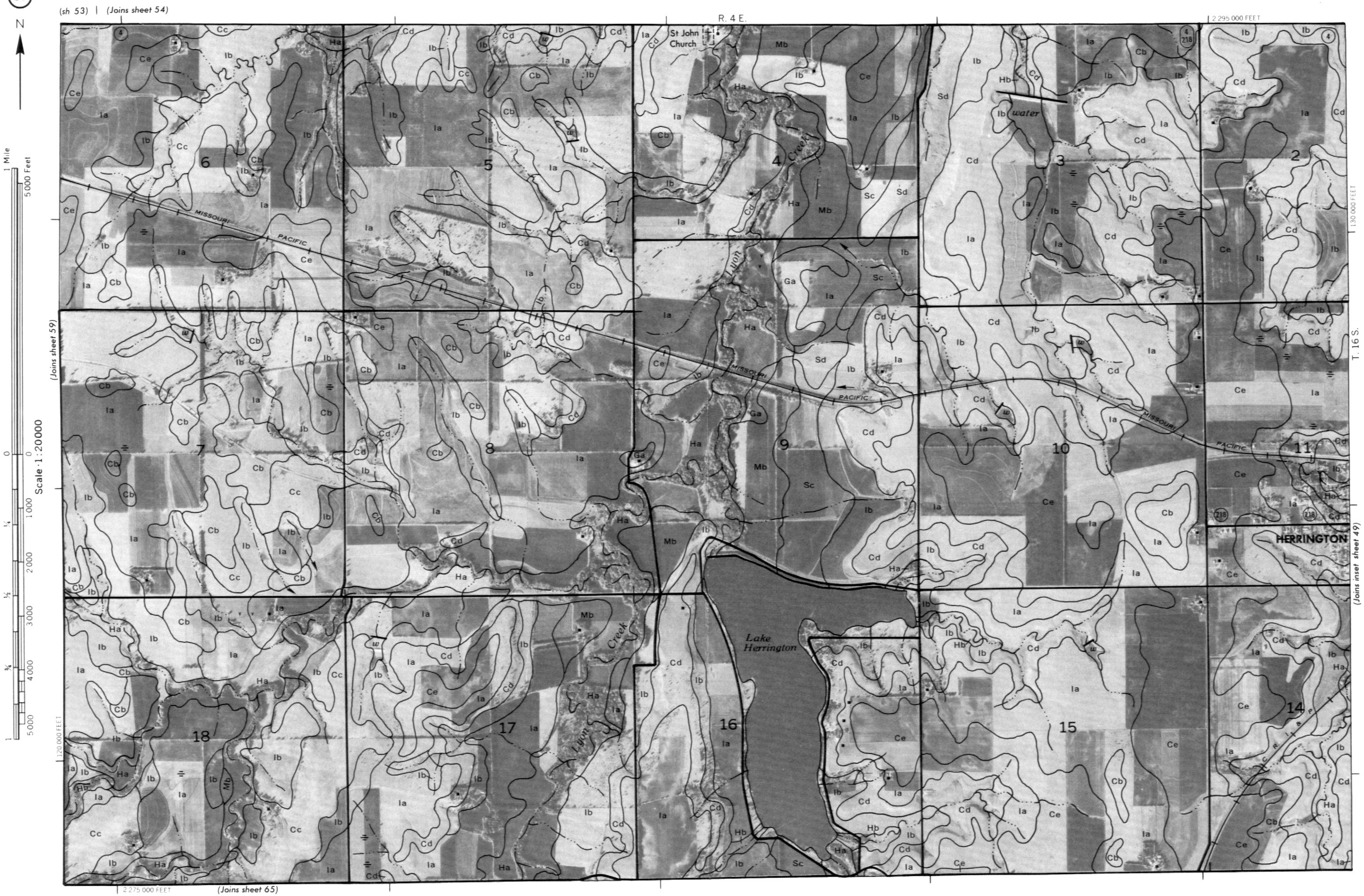


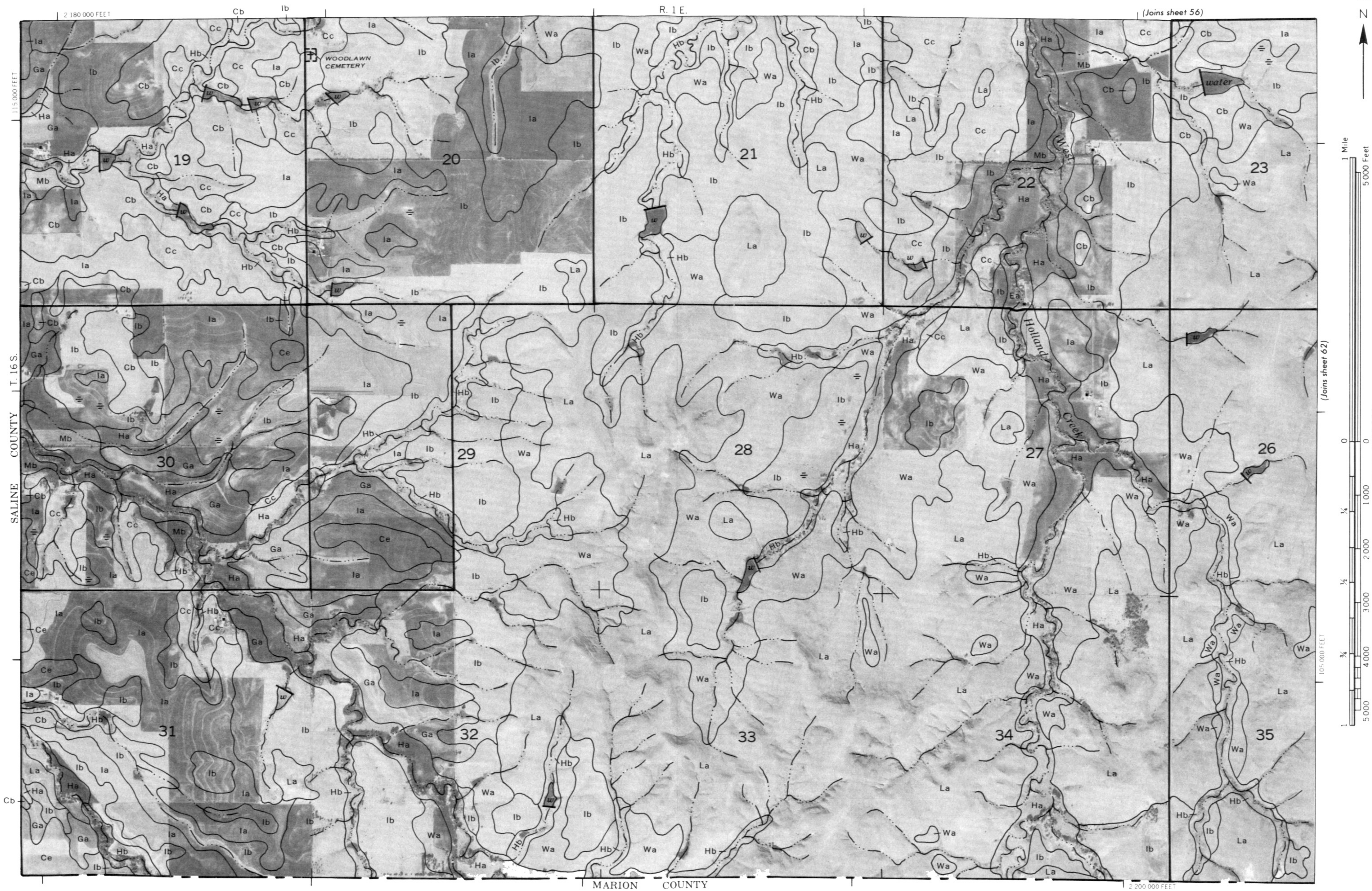
(Joins sheet 51)
(Joins sheet 58)
(Joins sheet 62)
(Joins sheet 56)
2 205 000 FEET
2 225 000 FEET
130 000 FEET
120 000 FEET
R. 1 E.
R. 2 E.
T. 16 S.
N
Scale 1:20000
1 Mile
5000 Feet
MISSOURI PACIFIC
Elmo
water
East Holland Creek
West Branch Turkey Creek
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

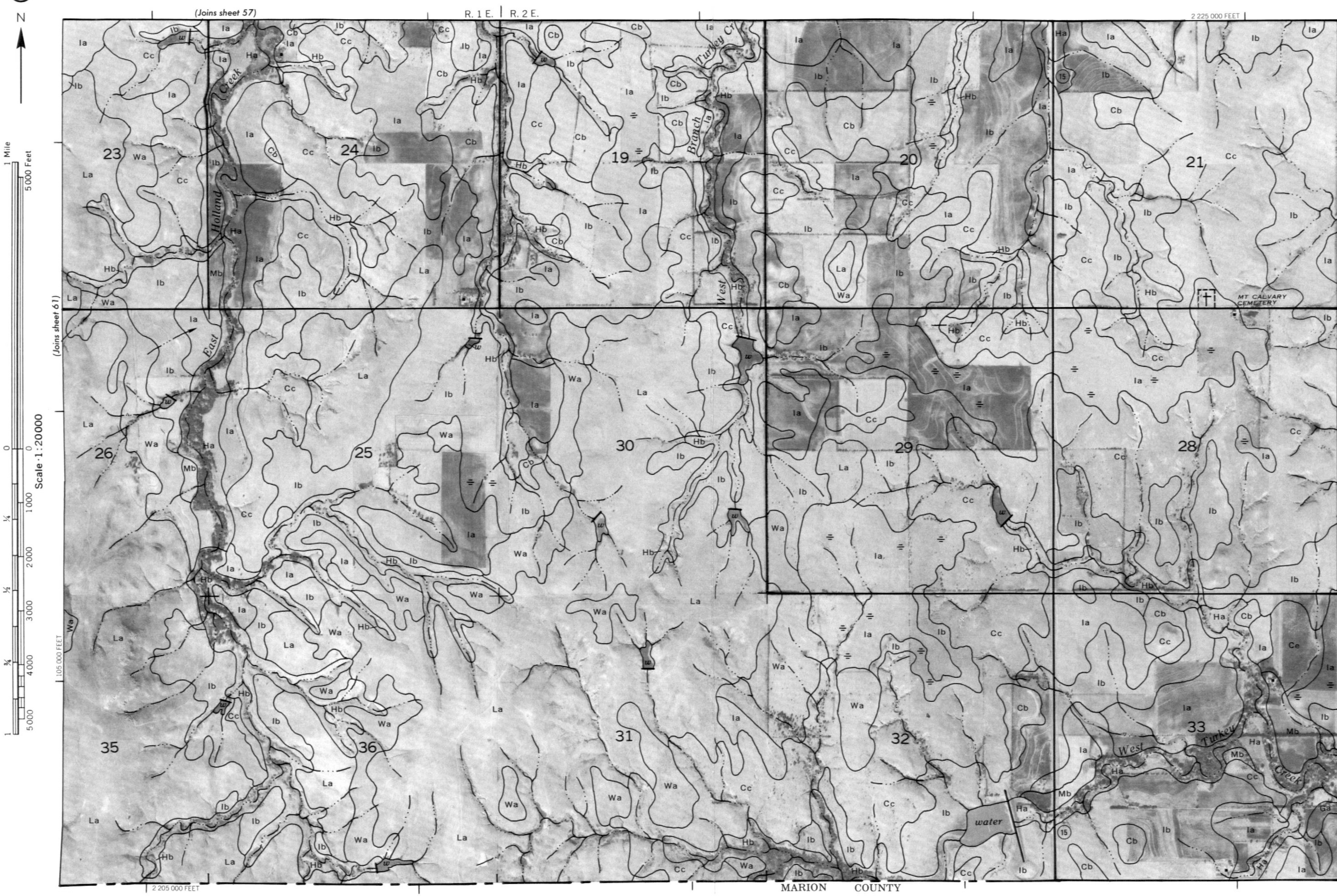
DICKINSON COUNTY, KANSAS — SHEET NUMBER 58

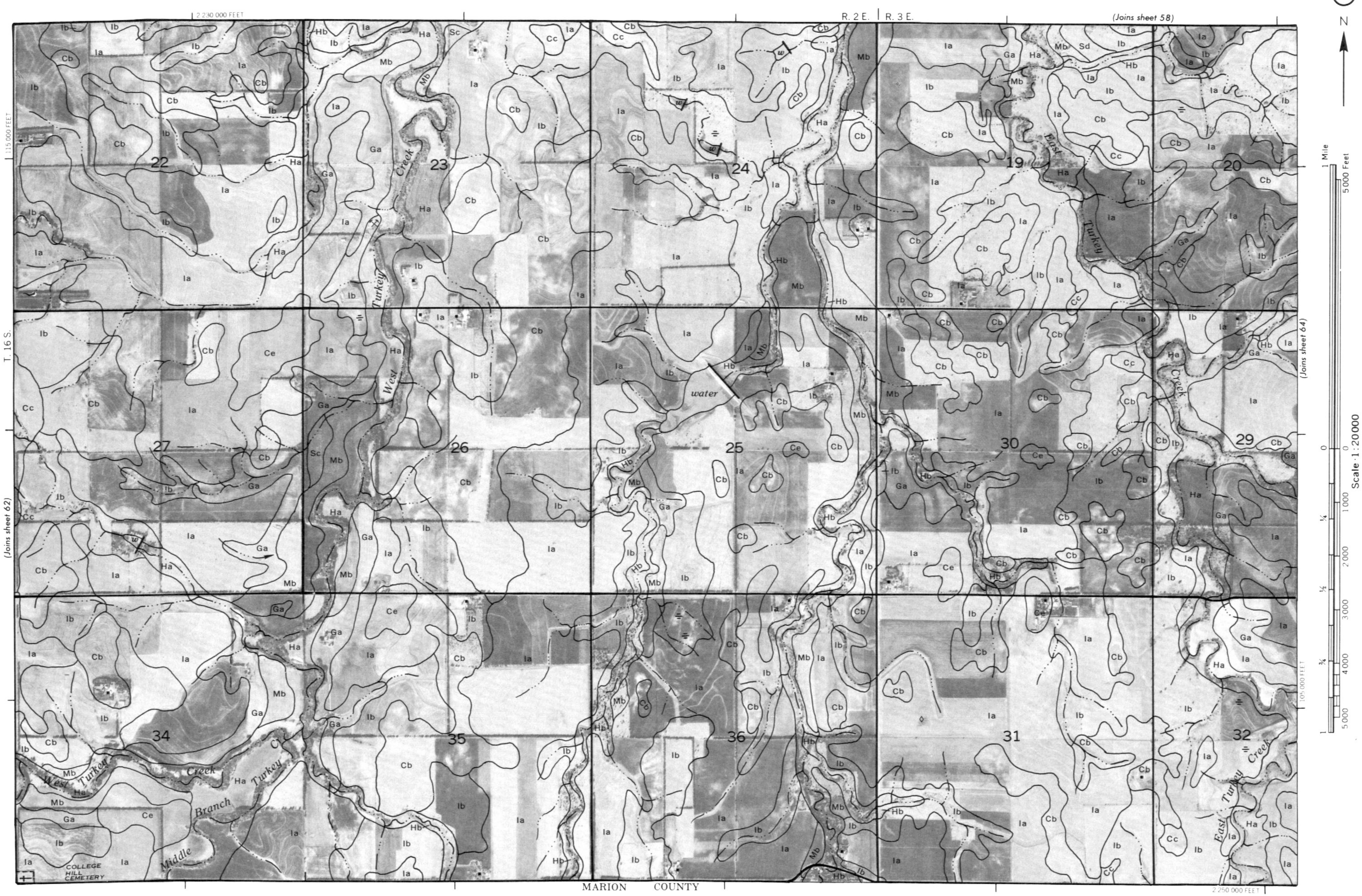


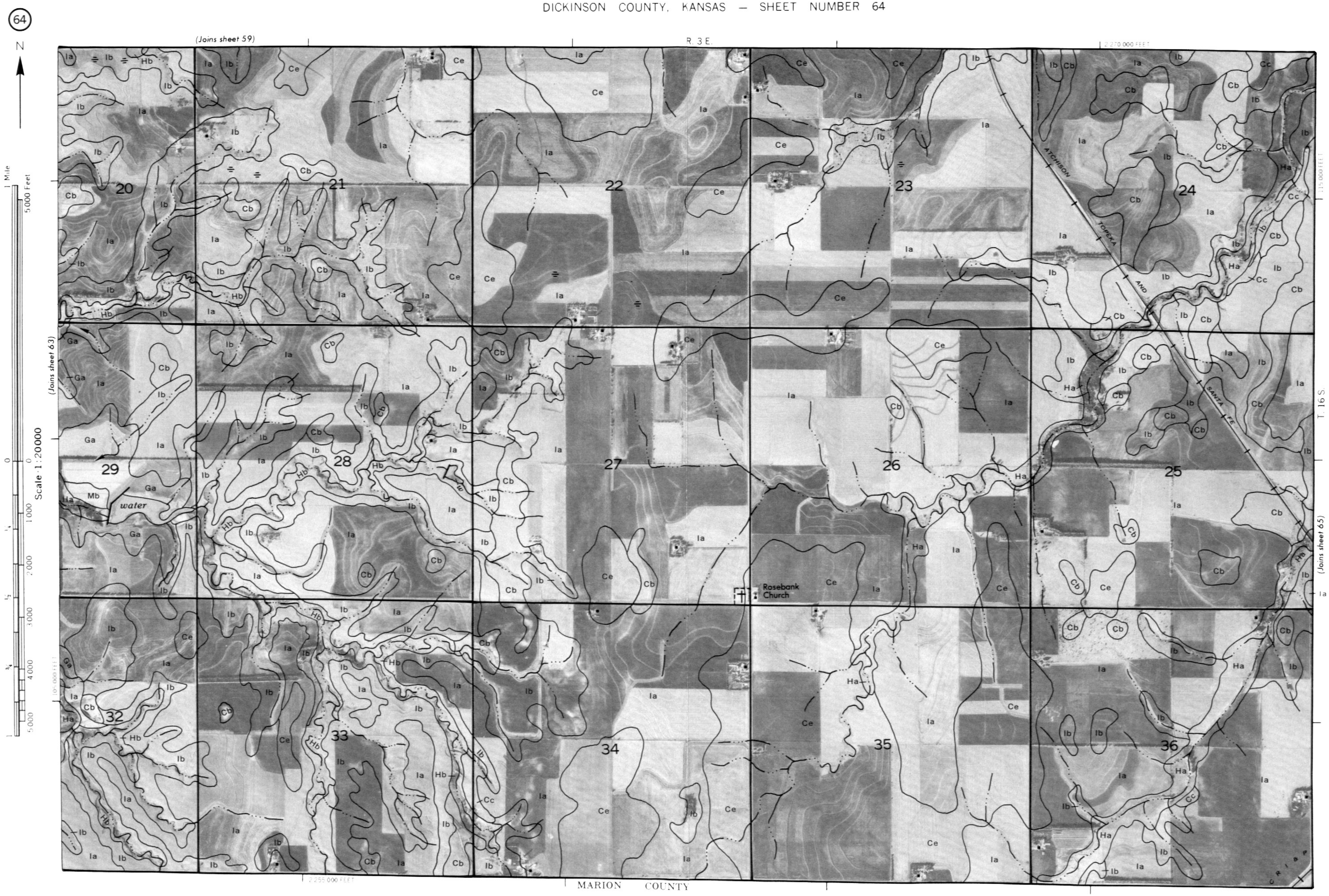

(sh 52)
(Joins sheet 53)
2 255 000 FEET
R. 3 E.
N
130 000 FEET
T. 16 S.
(Joins sheet 58)
(Joins sheet 60)
(Joins sheet 64)
2 270 000 FEET
120 000 FEET
Hope
ST PHILLIPS CEMETERY
MISSOURI PACIFIC
ATCHISON TOPEKA AND SANTA FE
West Branch
Lyon Cr
1 2 3 4 5 8 9 10 11 12 13 14 15 16 17
1 Mile
5000 Feet
Scale 1:20000
0 1/4 1/2 3/4 1
0 1000 2000 3000 4000 5000

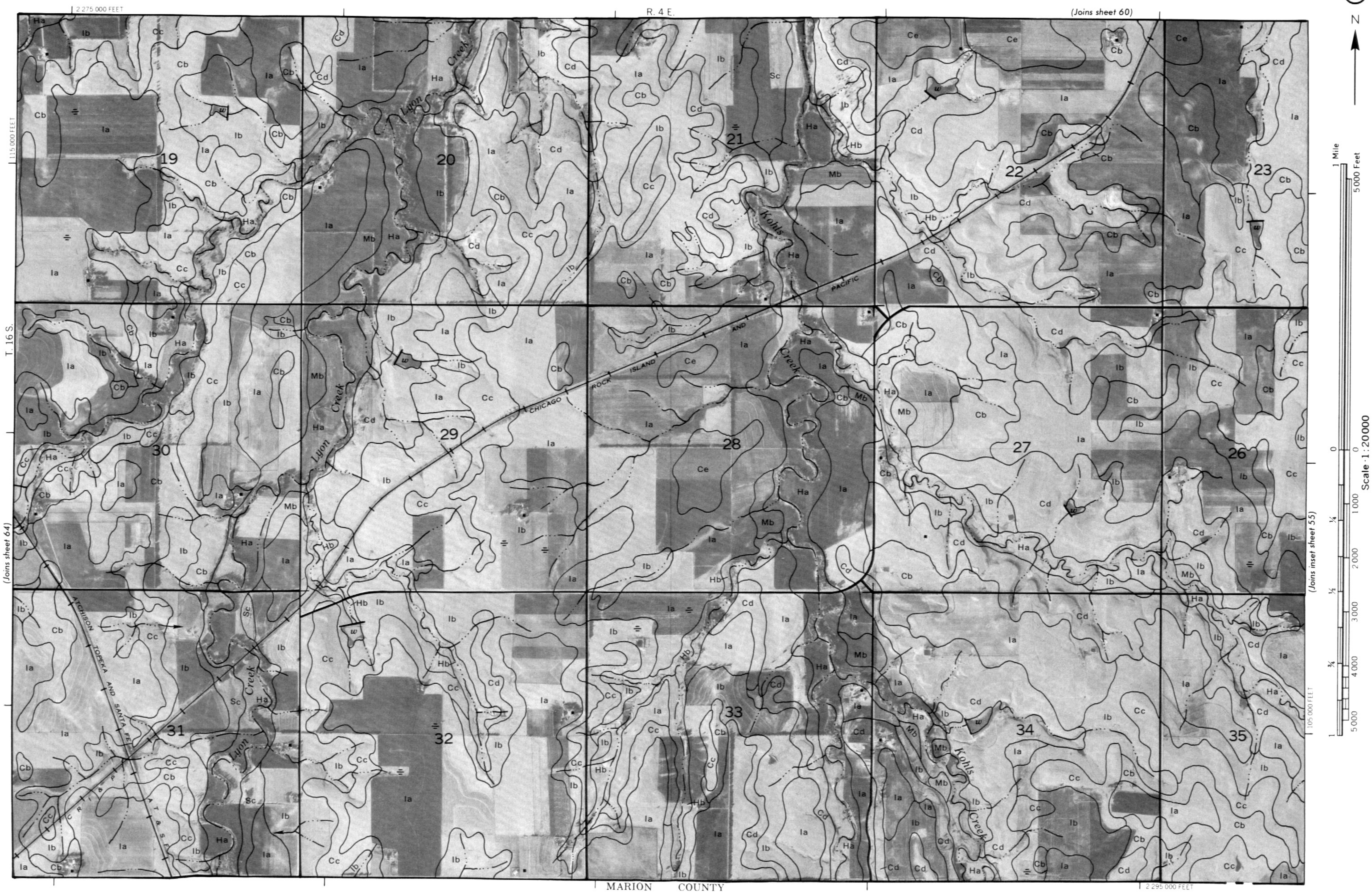

N
(sh 53)
(Joins sheet 54)
R. 4 E.
2 295 000 FEET
St John Church
water
MISSOURI PACIFIC
Lyon Creek
Lake Herrington
HERRINGTON
T. 16 S.
130 000 FEET
(Joins inset sheet 49)
(Joins sheet 59)
120 000 FEET
2 275 000 FEET
(Joins sheet 65)
Scale 1:20000
1 Mile
5000 Feet
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14


R. 1 E.
(Joins sheet 56)
(Joins sheet 62)
T. 16 S.
SALINE COUNTY
MARION COUNTY
WOODLAWN CEMETERY
West Creek
Holland Creek
water
2 180 000 FEET
2 200 000 FEET
115 000 FEET
105 000 FEET
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
N
Scale 1:20000
1 Mile
5000 Feet


N
(Joins sheet 57)
R. 1 E.
R. 2 E.
2 225 000 FEET
115 000 FEET
T. 16 S.
(Joins sheet 61)
(Joins sheet 63)
105 000 FEET
2 205 000 FEET
MARION COUNTY
1 Mile
5000 Feet
Scale 1:20000
Holland Creek
East
Turkey Cr
Branch
West
West Turkey Creek
MT CALVARY CEMETERY
water
15
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33


63
N
(Joins sheet 58)
R. 2 E.
R. 3 E.
2 230 000 FEET
115 000 FEET
T. 16 S.
(Joins sheet 62)
(Joins sheet 64)
MARION COUNTY
2 250 000 FEET
105 000 FEET
COLLEGE HILL CEMETERY
West Turkey Creek
East Turkey Creek
Middle Branch Turkey Creek
water
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000


64
N
(Joins sheet 59)
R. 3 E.
(Joins sheet 63)
(Joins sheet 65)
T. 16 S.
ATCHISON
TOPEKA
AND
SANTA FE
Rosebank
Church
water
CRISP
MARION COUNTY
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36
Scale 1:20000
1 Mile
5000 Feet
2 270 000 FEET
2 255 000 FEET


65
N
(Joins sheet 60)
(Joins sheet 64)
(Joins inset sheet 55)
2 275 000 FEET
2 295 000 FEET
115 000 FEET
105 000 FEET
R. 4 E.
T. 16 S.
MARION COUNTY
Lyon Creek
Kohls Creek
CHICAGO ROCK ISLAND AND PACIFIC
ATCHISON TOPEKA AND SANTA FE
C R I & P
A T & S F
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
1 Mile
5000 Feet
Scale 1:20000